

COASTAL DYNAMICS OF THUNDER BAY
LAKE SUPERIOR, 1983

September, 1986

Balbir Kohli
Great Lakes Section
Water Resources Branch
Ontario Ministry of the
Environment

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COASTAL DYNAMICS IN THUNDER BAY LAKE SUPERIOR, 1983

SUMMARY AND CONCLUSIONS

As part of the Great Lakes International Surveillance Plan (GLISP) for Lake Superior, knowledge of coastal dynamics of the nearshore areas of Thunder Bay was considered essential to explain spatial variability of water quality parameters. Four self-recording current instruments were operated in the study area from 5 May to 17 September, 1983 to measure and record water temperature, current speed and direction every 15 minutes. A general circulation from north to south was observed during the study period. Water movements towards north were 23% and towards south for 48% of the time. Currents in the area remained stagnant (speed < 5 cm/s) for 46% of the time while the coastal jetting episodes (speed > 20 cm/s) of 3 to 24 h persisted on several occasions. The average current speeds during the study (2.3 to 12.3 cm/s) were comparable to other regions of the Great Lakes, while the maximum speed recorded was 62 cm/s.

The thermal structure in the study region showed temperatures within the previously observed lake-wide temperature range. Several upwelling episodes were observed in the present study. Upwelling events enhance the water quality in the nearshore regions.

The water quality surveys (1983) indicated the zone of most degraded water quality to be close to the shoreline and extending offshore. South of this zone, ambient water quality was observed as expected by the southerly flow pattern. The time history of currents during the water quality surveys may be used to predict the fate of contaminants, by using appropriate predictive models available in the literature.

COASTAL DYNAMICS IN THUNDER BAY LAKE SUPERIOR, 1983

INTRODUCTION

Previous investigations of Thunder Bay by the Ontario Water Resources Commission (OWRC) showed accumulations of wood fibre discharged from paper mills, organic enrichment due to untreated domestic wastes and the impairment of water quality in the harbour (OWRC, 1967). The lower Kammistikwia (Kam) River, Inner Harbour and the adjacent sections of the Outer Harbour were contaminated by local industrial and municipal discharges (MOE, 1972).

The study on coastal dynamics and the study of Thunder Bay environmental conditions (Anderson, 1986) form part of the Ministry's contribution to the Great Lakes International Surveillance Plan (GLISP) for Lake Superior. The latter study analyzed selected pesticides, organic and metal trace contaminants in water and sediment samples. The coastal dynamics study was designed to help explain the spatial variations of some of the water quality parameters.

The predominant water users in the Thunder Bay area (Figure 1) are domestic and industrial water supply, waste disposal, hydro-electric power generation and commercial shipping. Recreational use in the area is limited to swimming, boating and angling. Some of the large industrial water users are: Abitibi Forest Products Ltd., Abitibi Provincial Paper, Abitibi Paper Co. Ltd. (Fort William Division, Great

Lakes Paper Co. Ltd. All of the industries provide treatment for process water prior to use.

The water quality of the coastal regions of Thunder Bay is influenced by the coastal dynamics of the area. Therefore, an understanding of the physical processes is considered necessary for the effective management of the coastal waters. Kohli (1976) studied water movements in the Inner and Outer Harbours of Thunder Bay and concluded that the general circulation was from north to south with high periods of stagnant currents (<5 cm/s). The currents were generally slow and the dispersion co-efficients were small compared to other nearshore areas of lower Great Lakes.

SURVEY DESIGN

The survey was designed to study the coastal climatology of the area, relative to the major industrial discharges and Kam River. Location 1407 (Figure 2) was selected near the major industrial discharge by Abitibi Provincial Paper, 1408 to monitor the effects of flow from the harbour, site 1409 near the river mouth and # 1410 to complete the general circulation patterns in the bay.

The water movement data were collected in the study area by the self-recording current instruments (Aanderra RCM4) set to record every 15 minutes. Four instruments (Table 1) were operated, in about a third of the water depth from surface, from 5 May to 17 September 1983 to measure and record water temperature, current speed and direction.

DATA ANALYSIS

In order to eliminate the short period fluctuations of the measurements, all data were pre-whitened (Blackman and Tukey, 1959) using bionomical coefficients (Panofsky and Brier, 1968). All data sets were subjected to statistical analyses to produce monthly frequencies of occurrence for current speed and direction (Tables 1.01 to 1.24 - Appendix), water temperature frequencies (Tables 2.01 - 2.04 - Appendix). Time series of water temperatures, current direction and speed and stick vectors were plotted (Figures 1.01 to 1.24). Rose histograms plots (Figures 2.01 to 2.24) display the current speed and direction. Progressive vector plots of the current data during the periods of water quality surveys were computer plotted (Figures 3.01 to 3.07 - Appendix). These plots show the trajectory of a particle, if released at the current meter location.

RESULTS

Thermal Structure

The study of thermal structure in the coastal waters is important as the thermal currents are generated by the presence of thermal gradients in the horizontal plane. The time history of water temperatures (Figures 1.01 to 1.24 - Appendix) illustrates several events of upwelling episodes (sudden drop of 5 to 10°C). Such events of sudden temperature drop are generally attributed to upwelling episodes which are caused when colder and deeper offshore water rises to the surface in the nearshore regions. The upwelling episodes are usually accompanied by

the onshore currents of average magnitude. The length or the duration of these episodes varied from 1/2 day to several days at all study locations from June to September 1983.

Csanady (1972) observed that complete mass exchange of water between inshore and offshore zones may occur during the adjustment from upwelling to downwelling and vice versa. Such an exchange is useful for water quality improvements in the nearshore areas.

The monthly mean temperature during the study period varied from 4.1 to 7.1°C (Table 2). Generally, higher water temperatures were observed during May 1983 as compared to June, July, August or September 1983 (Table 2). The mean monthly temperatures were plotted in Figure 3 and compared well with the previous lake-wide observations (IJC, 1977). Figure 3 illustrates the well-defined seasonal variations of the mean lake temperature and the large range of surface temperatures. Due to the non-seasonal variability of surface water temperature (IJC, 1977) the epilimnion would be relatively deep when the surface temperature is relatively low, and shallow when the surface temperature is relatively high.

Nearshore Currents

Knowledge of nearshore currents is considered essential for coastal water quality management since they provide the advection and dispersion mechanisms in the water body.

The currents were predominantly parallel to the shore (Figure 2) and the net circulation pattern indicates a general movement to south (Figure 4) during the summer months of this study. Table 3 presents the percentage of time the movements were towards north and south, illustrating the predominant motion towards south. The statistical results are summarized in Tables 4 - 7. The mean current speed varied from 2.3 to 12.5 cm/s, while the resultant speed ranged from 0.05 to 5.4 cm/s. The maximum speed recorded during the present study was 62 cm/s. During 1972-73, in Thunder Bay nearshore region, Kohli (1976) found the mean currents to vary from 0.5 to 4.3 cm/s and the resultant currents ranged between 0.4 and 3.1 cm/s, while 28 cm/s was the maximum speed recorded. The slower water movements during 1972-73 may be attributed to proximity of the current instruments to the lake bottom. In the earlier study, the instruments were operated at 2.0 to 3.0 m off the lake bottom, while they were operated in 2.0 to 3.0 m depth from the water surface, in the present study. Current speed is usually faster in the surface water due to wind stress and decreases with depth.

Stagnant Currents

The time series plots (Figures 1.01 - 1.24) illustrate the presence of stagnation periods (< 5 cm/s). Table 8 lists the percentage of time the currents were stagnant at each location and month. The stagnant currents prevailed for about 46% of the total study time but have persisted for up to one week as may be seen from the time series plots. During the stagnation periods, advection is less dominant and the

materials discharged tend to stay in the vicinity of the discharge location.

Coastal Jetting

When the current speeds in coastal waters exceed 20 cm/s, the phenomenon is generally referred to as 'Coastal Jetting'. Coastal jetting occurs in an adjustment zone where the shore perpendicular velocities tend to vanish and high currents are forced parallel to the shore (Csanady, 1972).

time series plots (Figures 1.01 to 1.24) depict the presence of coastal jetting. Table 9 presents the occurrence and the persistence of jetting periods during the study. Such periods continued for 3 h to 24 h. During coastal jetting, a particle released in the water column would travel about 0.75 to 1.0 km/h. Wastes discharged during these periods may not disperse effectively, but would be flushed away quickly.

Water Quality Surveys

Two water quality surveys were conducted in the nearshore region of Thunder Bay during spring (May 17, 18) and summer (July 25, 26, 27). These surveys (Anderson, 1986) were designed to assess the impact of industrial discharges along the shoreline. During the summer survey, currents were going towards south (same as the general circulation) except at location 1407 and 1408, but towards north at location 1410 where the movements were towards north. This location is just south of

the nearshore zone (Figure 5). The daily average current speeds during the survey periods and a day prior to that, are presented in Table 10. Coastal jetting during the water quality survey periods was not observed and thus the waste discharges may not be flushed out.

The water quality surveys (Anderson, 1986) indicated the zone (Figure 5) of most degraded water quality to be close to the shoreline and extending offshore towards the Welcome Island. South of this zone towards Pie Island, nutrient levels and heavy metal concentrations were similar to ambient conditions. The better water quality is observed at southern stations and this is attributed to the general water circulation in this area.

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TABLE 1: Current Instrument* Operations,
Thunder Bay, Lake Superior, 1983

Location Code	Water Depth	Instrument Depth From Bottom	Period of Operation	
			From	To
1407	15.5	12.2	14 May 83	17 Sept. 83
1408	12.5	8.5	15 May 83	17 Sept. 83
1409	8.8	6.1	5 May 83	18 July 83
			1 Aug. 83	17 Sept. 83
1410	8.8	6.1	14 May 83	17 Sept. 83

* Aanderra Current Instruments RCM4

TABLE 2: Mean Water Temperature (C),
Thunder Bay, Lake Superior, 1983

	Site 1407	Site 1408	Site 1409	Site 1410	Mean
May	5.32 (0.83)*	7.13 (1.65)	6.97 (1.38)	6.05 (0.96)	6.37
June	5.06 (2.54)	6.01 (2.60)	4.78 (3.10)	6.50 (2.75)	5.59
July	4.13 (2.75)	4.22 (2.55)	5.12 (2.56)	4.45 (2.93)	4.48
August	6.50 (2.46)	6.11 (2.27)	6.28 (2.03)	5.83 (2.06)	6.18
September	6.21 (2.80)	5.08 (3.11)	5.76 (3.05)	4.54 (2.19)	5.40

*Figures in brackets are the standard deviations (C).

TABLE 3: Water Movement Directions, Thunder Bay, Lake Superior, 1983
(PERCENT)

	# 1407		# 1408		# 1409		# 1410	
	S*	N*	S*	N*	S*	N*	S*	N*
May	58	30	33	39	46	35	53	32
June	50	22	54	9	37	40	36	34
July	44	26	55	5	43	34	43	30
August	58	14	55	9	49	26	46	26
September	61	6	56	10	37	15	49	22
Mean	54	20	51	14	42	30	45	29

Grand mean to N = 23%
S = 48%

* N - movements towards north
S - movements towards south

TABLE 4: Statistical Summary of Current Meter Operations,
Thunder Bay, Lake Superior, 1983

Location # 1407

	May	June	July	Aug.	Sept.
Resultant direction (0° as North)	200	209	223	223	223
Resultant speed (cm/s)	.80	2.03	1.88	4.69	5.39
Average speed (cm/s)	5.28	4.21	5.40	6.86	7.24
Maximum speed (cm/s)	20	17	22	36	30
Persistence factor	.15	.48	.35	.68	.74
Percentage of time going in direction of resultant	29	25	25	38	41
Total number of readings	1670	2880	2639	2976	1585
Interval of readings (min)	15	15	15	15	15

TABLE 5: Statistical Summary of Current Meter Operations,
Thunder Bay, Lake Superior, 1983

Location # 1408

	May	June	July	Aug.	Sept.
Resultant direction (0° as North)	25	189	185	178	181
Resultant speed (cm/s)	1.69	.99	1.63	4.75	4.14
Average speed (cm/s)	8.89	2.43	2.66	7.61	6.95
Maximum speed (cm/s)	27	19	18	31	32
Persistence factor	0.19	.41	.61	.62	.60
Percentage of time going in direction of resultant					
Total number of readings	706	2880	2646	2976	1595
Interval of readings (min)	15	15	15	15	15

TABLE 6: Statistical Summary of Current Meter Operations,
Thunder Bay, Lake Superior, 1983

Location # 1409

	May	June	July	Aug.	Sept.
Resultant direction (0° as North)	140	95	225	198	194
Resultant speed (cm/s)	2.66	1.88	48	1.91	2.62
Average speed (cm/s)	12.47	10.32	9.35	9.72	7.26
Maximum speed (cm/s)	62	31	27	24	27
Persistence factor	0.21	0.18	0.05	0.20	0.36
Percentage of time going in direction of resultant					
Total number of readings	2529	2880	1688	2976	1597
Interval of readings (min)	15	15	15	15	15

TABLE 7: Statistical Summary of Current Meter Operations,
Thunder Bay, Lake Superior, 1983

Location # 1410

	May	June	July	Aug.	Sept.
Resultant direction (0° as North)	172	203	201	186	179
Resultant speed (cm/s)	4.10	.37	.05	2.03	3.65
Average speed (cm/s)	9.83	2.40	2.33	8.41	8.46
Maximum speed (cm/s)	31	18	24	25	24
Persistence factor	0.42	0.15	0.02	0.24	0.43
Percentage of time going in direction of resultant					
Total number of readings	1564	2880	2648	2976	1601
Interval of readings (min)	15	15	15	15	15

TABLE 8: Periods of Stagnation (< 5 cm/s)
Thunder Bay, Lake Superior, 1983

Month	Location Code			
	1407	1408	1409	1410
May	58	26	16	32
June	58	90	13	90
July	52	87	18	93
August	46	40	19	29
September	43	41	40	24
Mean	51	57	21	54

Grand Mean = 46

TABLE 9: Periods of Coastal Jetting (> 20 cm/s)
Thunder Bay, Lake Superior, 1983

Location	Month	Length of Jetting Period (h)
1407	May	None
	June	None
	July	None
	August	6, 12, 12, 12, 12
	September	6
1408	May	None
	June	None
	July	None
	August	6, 6, 6, 12, 6
	September	3
1409	May	None
	June	3, 12, 3
	July	6, 3
	August	3, 3, 12, 3
	September	3
1410	May	6, 24
	June	None
	July	None
	August	3, 12
	September	None

TABLE 10: Daily Average Current Speeds
Thunder Bay, Lake Superior, 1983

Date*		1407	1408	1409	1410
May	15	5.4	7.4	5.9	5.4
	16	9.5	11.9	17.2	10.9
	17	9.5	10.2	5.4	9.5
July	24	4.4	1.8	-	1.7
	25	6.1	4.5	-	2.1
	26	4.1	4.5	-	1.7
	27	8.2	6.8	-	6.8

Notes: No jettings were observed during the survey periods
Short periods of stagnation were present during the
survey periods.

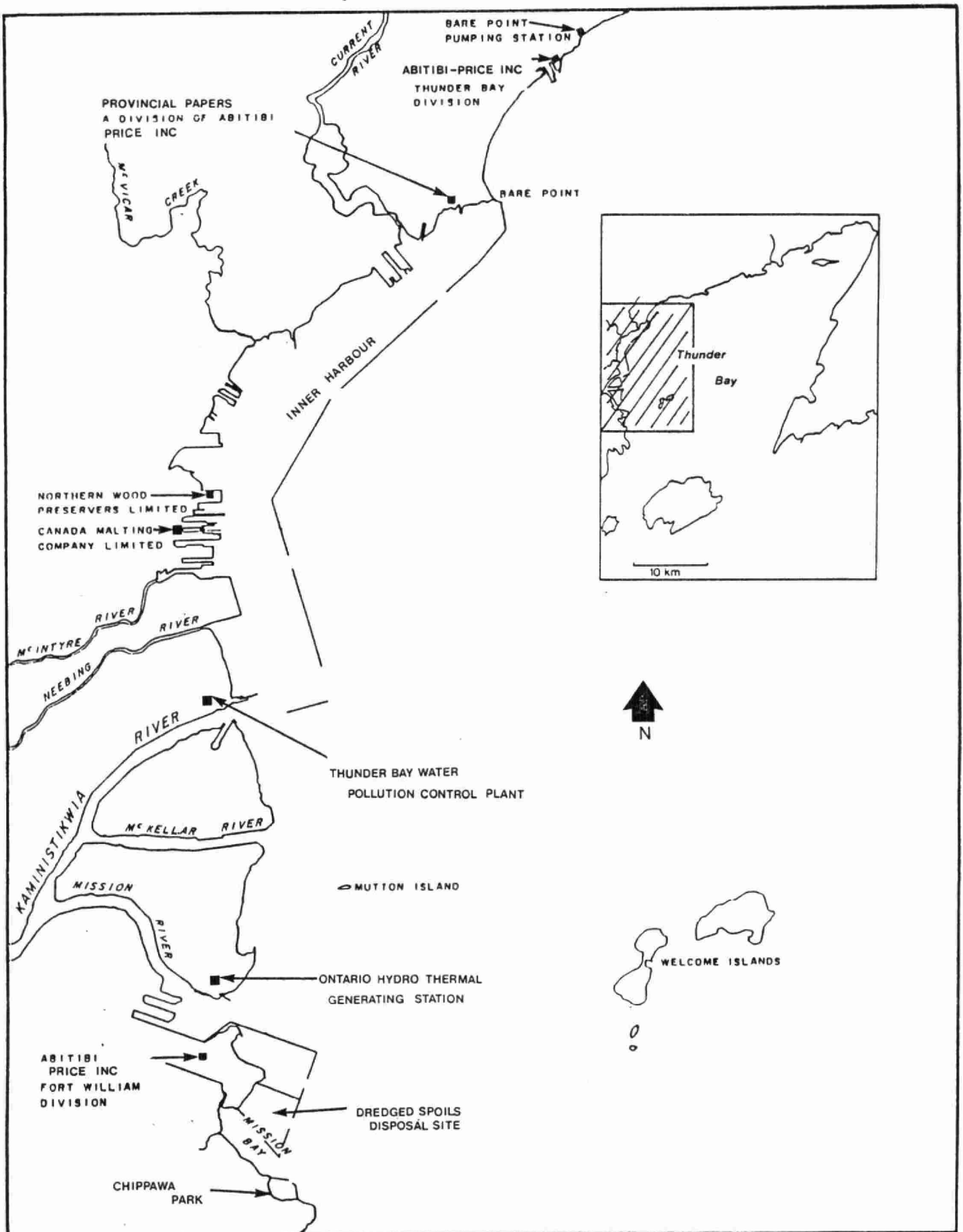


FIGURE 1 : INDUSTRIAL AND MUNICIPAL DISCHARGES, THUNDER BAY, LAKE SUPERIOR, 1983

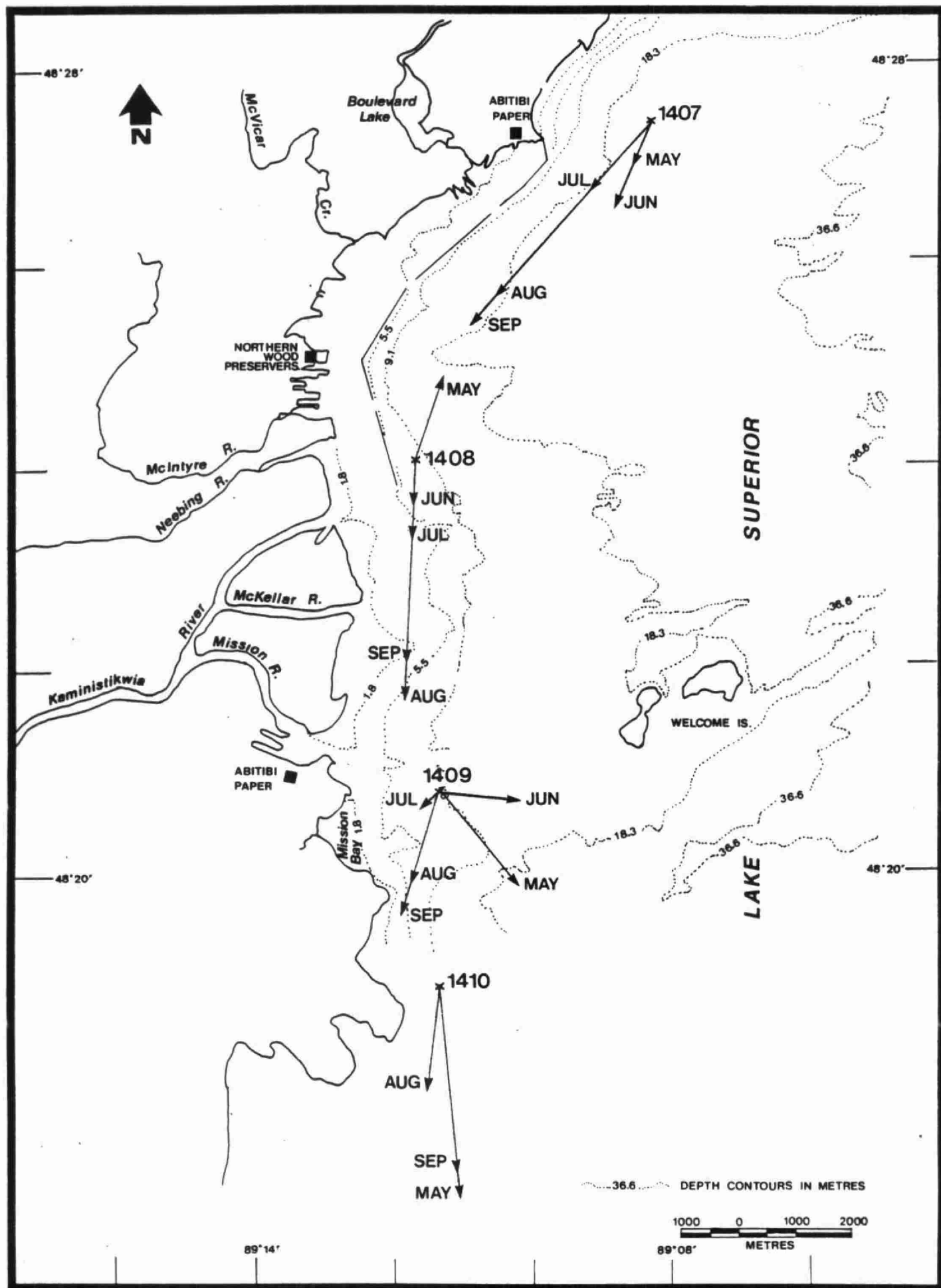
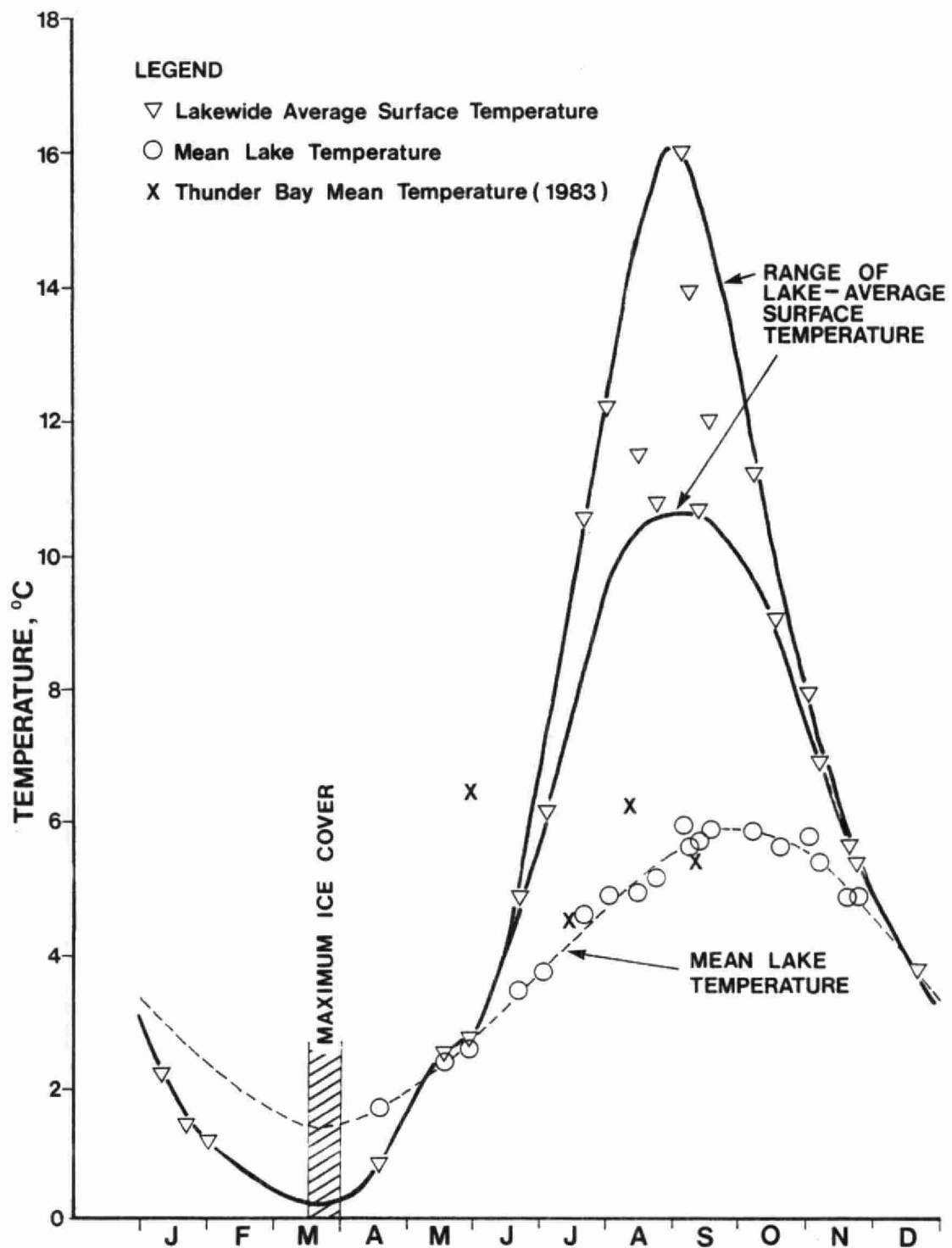


FIGURE 2 : RESULTANT CURRENTS, THUNDER BAY, LAKE SUPERIOR, 1983.



**FIGURE 3 : SEASONAL CYCLES OF LAKE SUPERIOR TEMPERATURE
1964 & 1969 (I J C, Vol. III, Part B, 1977)**

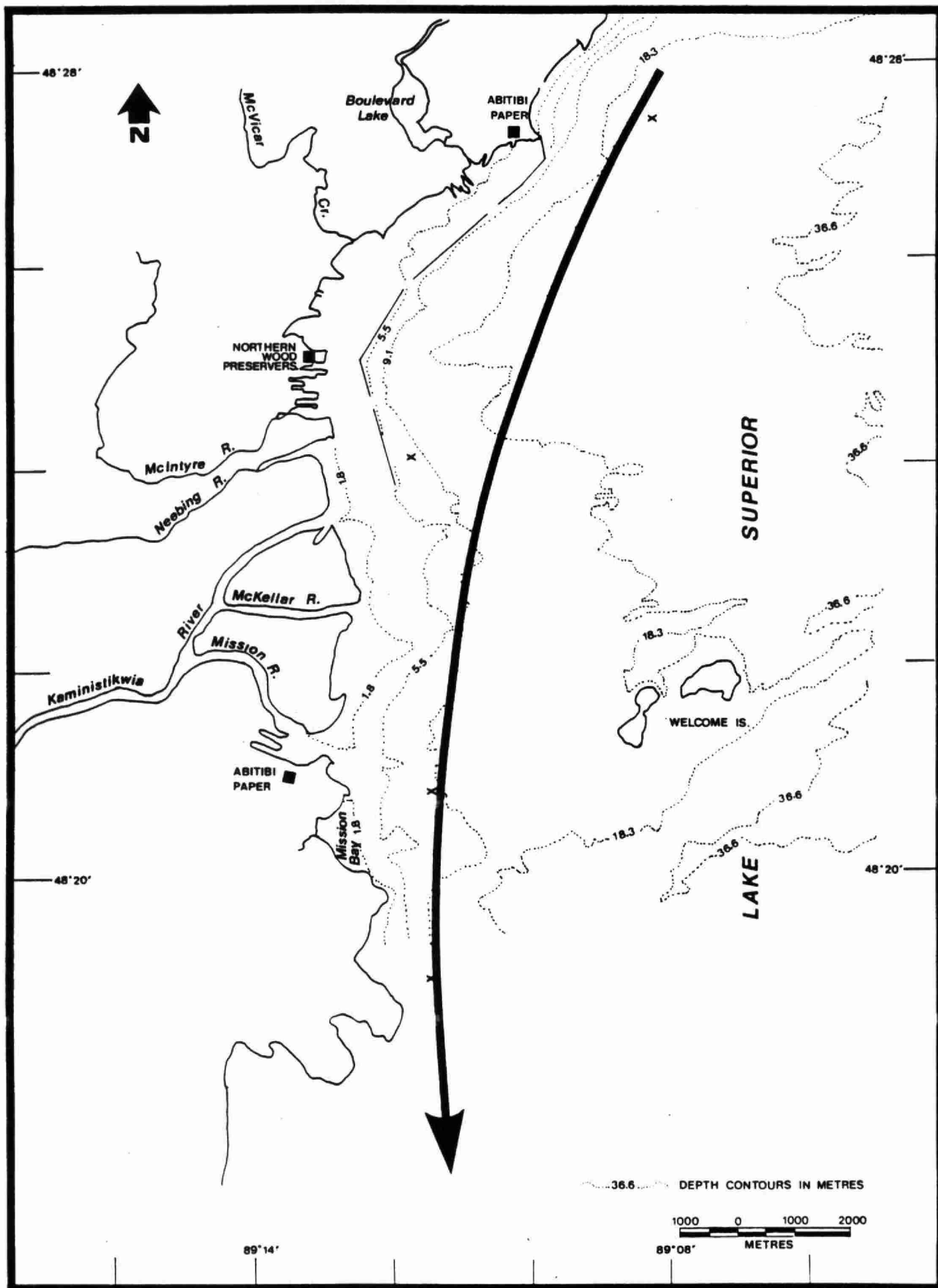


FIGURE 4 : SUMMER CIRCULATION, THUNDER BAY, LAKE SUPERIOR, 1983.

COASTAL DYNAMICS IN THUNDER BAY
LAKE SUPERIOR, 1983

APPENDIX

Statistical data summaries of current speed and directions are presented in Tables 1.01 to 1.20 while that for water temperatures can be found in Tables 2.01 to 2.04. Figures 1.01 to 1.23 illustrate the time series of the smoothed data for water temperatures, current direction and speed and stick vectors. Figures 2.01 to 2.20 display the frequency of occurrence of current speed and direction rose histograms. Progressive vector plots (PROVECS) of the currents during the water quality surveys are presented in Figures 3.01 to 3.07. These plots illustrate the trajectory of travel of a particle, if released at the current meter location.

TABLE 1.01

LOCATION CODE : 1407
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR

PERIOD : MAY 1983
 LATITUDE : 48 27 23 N
 LONGITUDE : 89 8 13 W

ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

			DIRECTION				IN DEGREES					
SPEED(CM/S)			337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW	SUMS
1.50	--	2.99	2.34	1.14	0.84	3.59	10.60	6.35	1.26	1.32	27.43	
3.00	--	4.99	4.13	5.15	0.78	0.48	9.76	9.34	0.54	0.54	30.72	
5.00	--	6.99	3.05	3.53	0.06	0.00	5.87	5.33	0.30	0.36	18.50	
7.00	--	8.99	1.56	2.46	0.00	0.00	1.56	2.16	0.06	0.42	8.20	
9.00	--	10.99	0.72	2.40	0.00	0.00	0.90	1.38	0.06	0.18	5.63	
11.00	--	12.99	0.60	1.44	0.00	0.00	1.38	1.08	0.00	0.00	4.49	
13.00	--	14.99	0.18	0.66	0.00	0.00	1.02	1.20	0.00	0.00	3.05	
15.00	--	19.60	0.66	0.90	0.00	0.00	0.24	0.18	0.00	0.00	1.98	
COLUMN SUMS			13.23	17.66	1.68	4.07	31.32	27.01	2.22	2.81	100.00	

RESULTANT CURRENT IS 0.80 CM/S AT 200. DEG. FROM MAG. NORTH
 MEAN CURRENT IS 5.28 CM/S
 MAXIMUM CURRENT IS 19.60 CM/S
 MINIMUM CURRENT IS 1.50 CM/S

TOTAL NO. OF POINTS 1670
 PERSISTANCE IS 0.15
 READINGS TAKEN EVERY 15.0 MINS.

METER OPERATIONS

METER OPERATED AT 12.2 M FROM BOTTOM IN 15.5 M OF WATER

STARTED AT 14.32 HRS. ON 14 TH DAY OF MAY 1983
 ENDED AT 23.47 HRS. ON 31 TH DAY OF MAY 1983

TABLE 1.02

LOCATION CODE : 1407
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR

PERIOD : JUN 1983
 LATITUDE : 48 27 23 N
 LONGITUDE : 89 8 13 W

ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

	DIRECTION									IN DEGREES
SPEED(CM/S)	337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW SUMS	
1.00 --	2.99	7.50	6.84	4.48	3.06	9.24	8.51	5.14	5.76	50.52
3.00 --	4.99	2.05	1.70	0.66	0.87	3.99	3.16	1.91	2.67	17.01
5.00 --	6.99	1.04	0.90	0.38	0.62	4.83	4.17	0.80	0.59	13.33
7.00 --	8.99	0.14	0.76	0.00	0.00	2.92	4.03	0.14	0.03	8.02
9.00 --	10.99	0.10	0.21	0.00	0.00	2.92	2.36	0.00	0.03	5.62
11.00 --	12.99	0.10	0.24	0.00	0.00	1.35	1.77	0.03	0.03	3.54
13.00 --	14.99	0.00	0.35	0.00	0.00	0.66	0.69	0.00	0.00	1.70
15.00 --	16.60	0.00	0.00	0.00	0.00	0.17	0.07	0.00	0.00	0.24
COLUMN SUMS	10.94	11.01	5.52	4.55	26.08	24.76	8.02	9.13	100.00	

RESULTANT CURRENT IS 2.03 CM/S AT 209. DEG. FROM MAG. NORTH
 MEAN CURRENT IS 4.21 CM/S
 MAXIMUM CURRENT IS 16.60 CM/S
 MINIMUM CURRENT IS 1.00 CM/S

TOTAL NO. OF POINTS 2880
 PERSISTANCE IS 0.48
 READINGS TAKEN EVERY 15.0 MINS.

METER OPERATIONS

METER OPERATED AT 12.2 M FROM BOTTOM IN 15.5 M OF WATER

STARTED AT 0.02 HRS. ON 1 TH DAY OF JUN 1983
 ENDED AT 23.47 HRS. ON 30 TH DAY OF JUN 1983

TABLE 1.03

LOCATION CODE : 1407
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR
 ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

PERIOD : JUL 1983
 LATITUDE : 48 27 23 N
 LONGITUDE: 89 8 13 W

FREQUENCY TABLE

		DIRECTION					IN DEGREES				
SPEED(CM/S)		337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW SUMS	
1.50 --	2.99	4.93	3.33	2.16	1.55	3.41	4.47	6.14	6.33	32.32	
3.00 --	4.99	3.98	1.78	0.64	0.61	3.45	4.13	2.88	4.36	21.83	
5.00 --	6.99	2.69	2.58	0.15	0.38	2.69	6.52	1.74	1.74	18.49	
7.00 --	8.99	2.77	1.36	0.15	0.00	2.61	3.30	0.04	0.38	10.61	
9.00 --	10.99	0.80	0.91	0.08	0.00	2.92	2.65	0.00	0.04	7.39	
11.00 --	12.99	0.19	0.91	0.04	0.00	1.40	2.58	0.00	0.00	5.12	
13.00 --	14.99	0.00	0.00	0.00	0.00	1.21	0.87	0.00	0.00	2.08	
15.00 --	21.80	0.00	0.00	0.00	0.00	1.89	0.27	0.00	0.00	2.16	
COLUMN SUMS		15.35	10.88	3.22	2.54	19.59	24.78	10.80	12.85	100.00	

RESULTANT CURRENT IS 1.88 CM/S AT 223. DEG. FROM MAG. NORTH TOTAL NO. OF POINTS 2639
 MEAN CURRENT IS 5.40 CM/S PERSISTANCE IS 0.35
 MAXIMUM CURRENT IS 21.80 CM/S READINGS TAKEN EVERY 15.0 MINS.
 MINIMUM CURRENT IS 1.50 CM/S

METER OPERATIONS

METER OPERATED AT 12.2 M FROM BOTTOM IN 15.5 M OF WATER

STARTED AT 0.02 HRS. ON 1 TH DAY OF JUL 1983
 ENDED AT 11.32 HRS. ON 28 TH DAY OF JUL 1983

TABLE 1.04

LOCATION CODE : 1407

PERIOD : AUG 1983

AREA : THUNDER BAY

LATITUDE : 48 27 23 N

LAKE : L. SUPERIOR

LONGITUDE: 89 8 13 W

ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

			DIRECTION				IN DEGREES				
SPEED(CM/S)			337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW SUMS
1.50	--	5.99	9.91	0.00	0.00	0.00	4.94	18.68	9.61	12.63	55.78
6.00	--	9.99	4.07	0.00	0.00	0.03	5.78	10.62	3.70	1.28	25.47
10.00	--	13.99	0.57	0.00	0.00	0.03	2.89	3.16	0.47	0.00	7.12
14.00	--	17.99	0.07	0.00	0.00	0.00	2.22	2.55	0.00	0.00	4.84
18.00	--	21.99	0.00	0.00	0.00	0.00	1.44	1.92	0.00	0.00	3.36
22.00	--	25.99	0.00	0.00	0.00	0.00	1.04	1.08	0.00	0.00	2.12
26.00	--	29.99	0.00	0.00	0.00	0.00	0.60	0.27	0.00	0.00	0.87
30.00	--	35.50	0.00	0.00	0.00	0.00	0.40	0.03	0.00	0.00	0.44
COLUMN SUMS			14.62	0.00	0.00	0.07	19.32	38.31	13.78	13.91	100.00

RESULTANT CURRENT IS 4.69 CM/S AT 223. DEG. FROM MAG. NORTH

TOTAL NO. OF POINTS 2976

MEAN CURRENT IS 6.86 CM/S

PERSISTANCE IS 0.68

MAXIMUM CURRENT IS 35.50 CM/S

READINGS TAKEN EVERY 15.0 MINS.

MINIMUM CURRENT IS 1.50 CM/S

METER OPERATIONS

METER OPERATED AT 12.2 M FROM BOTTOM IN 15.5 M OF WATER

STARTED AT 0.03 HRS. ON 1 TH DAY OF AUG 1983

ENDED AT 23.48 HRS. ON 31 TH DAY OF AUG 1983

TABLE 1.05

LOCATION CODE : 1407
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR
 PERIOD : SEP 1983
 LATITUDE : 48 27 23 N
 LONGITUDE : 89 8 13 W
 ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

		DIRECTION					IN DEGREES			
SPEED(CM/S)		337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW SUMS
1.50 --	4.99	3.22	0.00	0.00	0.00	7.44	10.47	7.89	13.50	42.52
5.00 --	8.99	2.21	0.00	0.00	0.00	3.66	13.00	3.85	7.38	30.09
9.00 --	12.99	0.38	0.00	0.00	0.00	1.89	9.02	0.63	0.00	11.92
13.00 --	16.99	0.00	0.00	0.00	0.00	2.97	4.73	0.00	0.00	7.70
17.00 --	20.99	0.00	0.00	0.00	0.00	2.78	2.33	0.00	0.00	5.11
21.00 --	24.99	0.00	0.00	0.00	0.00	1.39	0.57	0.00	0.00	1.96
25.00 --	28.99	0.00	0.00	0.00	0.00	0.13	0.25	0.00	0.00	0.38
29.00 --	29.90	0.00	0.00	0.00	0.00	0.06	0.25	0.00	0.00	0.32
COLUMN SUMS		5.80	0.00	0.00	0.00	20.32	40.63	12.37	20.88	100.00

RESULTANT CURRENT IS 5.39 CM/S AT 223. DEG. FROM MAG. NORTH
 MEAN CURRENT IS 7.24 CM/S
 MAXIMUM CURRENT IS 29.90 CM/S
 MINIMUM CURRENT IS 1.50 CM/S
 TOTAL NO. OF POINTS 1585
 PERSISTANCE IS 0.74
 READINGS TAKEN EVERY 15.0 MINS.

METER OPERATIONS

METER OPERATED AT 12.2 M FROM BOTTOM IN 15.5 M OF WATER

STARTED AT 0.03 HRS. ON 1 TH DAY OF SEP 1983
 ENDED AT 12.03 HRS. ON 17 TH DAY OF SEP 1983

TABLE 1.06

LOCATION CODE : 1408
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR

PERIOD : MAY 1983
 LATITUDE : 48 24 8 N
 LONGITUDE: 89 11 41 W

ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

			DIRECTION				IN DEGREES				
SPEED(CM/S)			337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW SUMS
1.50 --	4.99		0.99	1.98	2.55	3.54	6.52	3.40	1.56	1.84	22.38
5.00 --	7.99		2.97	1.84	2.83	5.67	6.66	0.71	0.00	0.14	20.82
8.00 --	10.99		7.79	4.11	1.27	3.97	8.36	1.13	0.71	1.70	29.04
11.00 --	13.99		6.52	0.28	0.00	0.42	5.67	0.00	0.28	0.85	14.02
14.00 --	16.99		6.09	0.00	0.00	0.00	0.99	0.00	0.00	0.42	7.51
17.00 --	19.99		3.26	0.00	0.00	0.00	0.00	0.00	0.00	0.14	3.40
20.00 --	22.99		0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.71
23.00 --	26.90		2.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.12
COLUMN SUMS			30.31	8.22	6.66	13.60	28.19	5.24	2.55	5.24	100.00

RESULTANT CURRENT IS	1.69 CM/S AT 25. DEG. FROM MAG. NORTH	TOTAL NO. OF POINTS	706
MEAN CURRENT IS	8.89 CM/S	PERSISTANCE IS	0.19
MAXIMUM CURRENT IS	26.90 CM/S	READINGS TAKEN EVERY	15.0 MINS.
MINIMUM CURRENT IS	1.50 CM/S		

METER OPERATIONS

METER OPERATED AT 6.1 M FROM BOTTOM IN 8.8 M OF WATER

STARTED AT 15.34 HRS. ON 14 TH DAY OF MAY 1983
 ENDED AT 23.49 HRS. ON 21 TH DAY OF MAY 1983

TABLE 1.07

LOCATION CODE : 1408
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR
 PERIOD : JUN 1983
 LATITUDE : 48 24 8 N
 LONGITUDE: 89 11 41 W
 ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

		DIRECTION					IN DEGREES				
SPEED(CM/S)		337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW SUMS	
1.50 --	1.99	3.02	2.43	2.40	10.56	27.47	11.88	7.57	6.15	71.46	
2.00 --	2.99	0.52	0.62	0.21	1.18	2.88	1.01	1.63	0.42	8.47	
3.00 --	3.99	0.59	0.17	0.03	0.97	3.09	1.08	1.42	0.31	7.67	
4.00 --	4.99	0.52	0.00	0.07	0.35	1.04	0.14	0.31	0.24	2.67	
5.00 --	5.99	0.28	0.03	0.00	0.38	1.98	0.00	0.03	0.07	2.78	
6.00 --	6.99	0.10	0.00	0.03	0.66	1.32	0.07	0.00	0.07	2.26	
7.00 --	7.99	0.14	0.00	0.00	0.28	0.66	0.03	0.00	0.21	1.32	
8.00 --	11.90	0.90	0.00	0.00	0.59	1.04	0.00	0.00	0.83	3.37	
COLUMN SUMS		6.08	3.26	2.74	14.97	39.48	14.20	10.97	8.30	100.00	

RESULTANT CURRENT IS 1.02 CM/S AT 188. DEG. FROM MAG. NORTH
 MEAN CURRENT IS 2.40 CM/S
 MAXIMUM CURRENT IS 11.90 CM/S
 MINIMUM CURRENT IS 1.50 CM/S
 TOTAL NO. OF POINTS 2880
 PERSISTANCE IS 0.43
 READINGS TAKEN EVERY 15.0 MINS.

METER OPERATIONS

METER OPERATED AT 6.1 M FROM BOTTOM IN 8.8 M OF WATER

STARTED AT 0.04 HRS. ON 1 TH DAY OF JUN 1983
 ENDED AT 23.49 HRS. ON 30 TH DAY OF JUN 1983

TABLE 1.08

LOCATION CODE : 1408
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR

PERIOD : JUL 1983
 LATITUDE : 48 24 8 N
 LONGITUDE : 89 11 41 W

ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

			DIRECTION				IN DEGREES				
SPEED(CM/S)			337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW SUMS
1.50 --	3.99		2.95	1.51	2.00	12.66	29.29	15.57	9.03	10.13	83.14
4.00 --	5.99		0.34	0.08	0.04	1.59	2.61	1.40	0.42	1.25	7.71
6.00 --	7.99		0.00	0.00	0.00	0.53	1.70	0.57	0.23	0.15	3.17
8.00 --	9.99		0.00	0.00	0.00	0.57	1.63	0.00	0.00	0.00	2.19
10.00 --	11.99		0.00	0.00	0.00	0.68	1.13	0.00	0.00	0.00	1.81
12.00 --	13.99		0.00	0.00	0.00	0.45	0.53	0.00	0.00	0.00	0.98
14.00 --	15.99		0.00	0.00	0.00	0.04	0.68	0.00	0.00	0.00	0.72
16.00 --	18.30		0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.26
COLUMN SUMS			3.29	1.59	2.04	16.52	37.83	17.54	9.67	11.53	100.00

RESULTANT CURRENT IS 1.63 CM/S AT 185. DEG. FROM MAG. NORTH
 MEAN CURRENT IS 2.66 CM/S
 MAXIMUM CURRENT IS 18.30 CM/S
 MINIMUM CURRENT IS 1.50 CM/S

TOTAL NO. OF POINTS 2646
 PERSISTANCE IS 0.61
 READINGS TAKEN EVERY 15.0 MINS.

METER OPERATIONS

METER OPERATED AT 6.1 M FROM BOTTOM IN 8.8 M OF WATER

STARTED AT 0.04 HRS. ON 1 TH DAY OF JUL 1983
 ENDED AT 13.19 HRS. ON 28 TH DAY OF JUL 1983

TABLE 1.09

LOCATION CODE : 1408
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR

PERIOD : AUG 1983
 LATITUDE : 48 24 8 N
 LONGITUDE: 89 11 41 W

ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

		DIRECTION					IN DEGREES				
SPEED(CM/S)		337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW SUMS	
1.50 --	4.99	3.09	2.49	2.92	7.56	9.31	7.26	3.43	3.80	39.85	
5.00 --	8.99	2.52	0.34	0.30	3.76	12.37	5.98	2.99	4.94	33.20	
9.00 --	12.99	0.67	0.03	0.00	1.28	6.55	0.44	0.10	1.51	10.58	
13.00 --	16.99	0.13	0.00	0.00	0.91	5.68	0.20	0.00	0.47	7.39	
17.00 --	20.99	0.00	0.00	0.00	0.60	3.83	0.00	0.00	0.00	4.44	
21.00 --	24.99	0.00	0.00	0.00	0.30	1.85	0.00	0.00	0.00	2.15	
25.00 --	28.99	0.00	0.00	0.00	0.47	1.78	0.00	0.00	0.00	2.25	
29.00 --	31.20	0.00	0.00	0.00	0.10	0.03	0.00	0.00	0.00	0.13	
COLUMN SUMS		6.42	2.86	3.23	14.99	41.40	13.88	6.52	10.72	100.00	

RESULTANT CURRENT IS 4.75 CM/S AT 178. DEG. FROM MAG. NORTH
 MEAN CURRENT IS 7.61 CM/S
 MAXIMUM CURRENT IS 31.20 CM/S
 MINIMUM CURRENT IS 1.50 CM/S

TOTAL NO. OF POINTS 2976
 PERSISTANCE IS 0.62
 READINGS TAKEN EVERY 15.0 MINS.

METER OPERATIONS

METER OPERATED AT 6.1 M FROM BOTTOM IN 8.8 M OF WATER

STARTED AT 0.06 HRS. ON 1 TH DAY OF AUG 1983
 ENDED AT 23.51 HRS. ON 31 TH DAY OF AUG 1983

TABLE 1.10

LOCATION CODE : 1408
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR

PERIOD : SEP 1983
 LATITUDE : 48 24 8 N
 LONGITUDE : 89 11 41 W

ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

		DIRECTION				IN DEGREES				
SPEED(CM/S)		337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW SUMS
1.50	-- 4.99	3.32	2.51	1.76	3.95	8.71	9.22	5.96	6.02	41.44
5.00	-- 8.99	3.45	0.31	0.25	2.51	12.23	3.13	3.01	5.14	30.03
9.00	-- 12.99	0.75	0.00	0.00	2.70	11.79	0.31	0.00	0.94	16.49
13.00	-- 16.99	0.00	0.00	0.00	0.94	7.46	0.00	0.00	0.00	8.40
17.00	-- 20.99	0.00	0.00	0.00	0.25	2.01	0.00	0.00	0.00	2.26
21.00	-- 24.99	0.00	0.00	0.00	0.31	0.44	0.00	0.00	0.00	0.75
25.00	-- 28.99	0.00	0.00	0.00	0.00	0.38	0.00	0.00	0.00	0.38
29.00	-- 32.30	0.00	0.00	0.00	0.13	0.13	0.00	0.00	0.00	0.25
COLUMN SUMS		7.52	2.82	2.01	10.78	43.13	12.66	8.97	12.10	100.00

RESULTANT CURRENT IS	4.14 CM/S AT 181. DEG. FROM MAG. NORTH	TOTAL NO. OF POINTS	1595
MEAN CURRENT IS	6.95 CM/S	PERSISTANCE IS	0.60
MAXIMUM CURRENT IS	32.30 CM/S	READINGS TAKEN EVERY	15.0 MINS.
MINIMUM CURRENT IS	1.50 CM/S		

METER OPERATIONS

METER OPERATED AT 6.1 M FROM BOTTOM IN 8.8 M OF WATER

STARTED AT 0.06 HRS. ON 1 TH DAY OF SEP 1983
 ENDED AT 14.36 HRS. ON 17 TH DAY OF SEP 1983

TABLE 1.11

LOCATION CODE : 1409
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR

PERIOD : MAY 1983
 LATITUDE : 48 20 49 N
 LONGITUDE: 89 11 22 W

ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

		DIRECTION					IN DEGREES				
SPEED(CM/S)		337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW SUMS	
1.50 --	4.99	1.23	1.19	2.61	1.15	2.33	2.45	0.47	0.40	11.82	
5.00 --	8.99	1.15	3.04	2.14	1.78	5.18	3.52	0.47	0.40	17.67	
9.00 --	12.99	5.85	6.84	0.67	2.06	7.71	2.93	0.28	0.28	26.61	
13.00 --	16.99	5.14	2.69	0.24	2.69	9.65	0.63	0.55	0.43	22.02	
17.00 --	20.99	3.91	0.43	0.00	0.99	6.60	0.08	0.04	0.40	12.46	
21.00 --	24.99	1.90	0.12	0.00	0.24	3.08	0.00	0.00	0.00	5.34	
25.00 --	28.99	1.62	0.00	0.00	0.04	1.74	0.00	0.00	0.00	3.40	
29.00 --	32.10	0.32	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.67	
COLUMN SUMS		21.12	14.31	5.65	8.94	36.65	9.61	1.82	1.90	100.00	

RESULTANT CURRENT IS 2.67 CM/S AT 140. DEG. FROM MAG. NORTH
 MEAN CURRENT IS 12.45 CM/S
 MAXIMUM CURRENT IS 32.10 CM/S
 MINIMUM CURRENT IS 1.50 CM/S

TOTAL NO. OF POINTS 2529
 PERSISTANCE IS 0.21
 READINGS TAKEN EVERY 15.0 MINS.

METER OPERATIONS

METER OPERATED AT 6.1 M FROM BOTTOM IN 8.8 M OF WATER

STARTED AT 15.51 HRS. ON 5 TH DAY OF MAY 1983
 ENDED AT 23.51 HRS. ON 31 TH DAY OF MAY 1983

TABLE 1.12

LOCATION CODE : 1409
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR

PERIOD : JUN 1983
 LATITUDE : 48 20 49 N
 LONGITUDE : 89 11 22 W

ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

		DIRECTION					IN DEGREES				
SPEED(CM/S)		337.50-	22.50-	67.50-	112.50-	157.50-	202.50-	247.50-	292.50-	ROW SUMS	
		22.49	67.49	112.49	157.49	202.49	247.49	292.49	337.49		
1.50	--	3.99	1.63	1.49	0.94	0.56	1.35	1.18	0.62	1.53	9.31
4.00	--	6.99	1.53	2.26	1.94	0.73	2.29	3.61	1.15	0.49	13.99
7.00	--	9.99	1.77	7.78	2.71	1.94	5.94	4.58	1.08	0.73	26.53
10.00	--	12.99	2.43	7.95	1.84	2.05	6.35	2.78	0.97	0.76	25.14
13.00	--	15.99	2.81	4.86	0.73	0.83	2.99	1.53	0.07	0.14	13.96
16.00	--	18.99	2.01	1.56	0.00	0.52	1.94	0.10	0.00	0.03	6.18
19.00	--	21.99	0.90	0.49	0.03	0.14	1.04	0.00	0.00	0.00	2.60
22.00	--	28.90	0.56	0.17	0.03	0.03	1.49	0.00	0.00	0.00	2.29
COLUMN SUMS		13.65	26.56	8.23	6.81	23.40	13.78	3.89	3.68	100.00	

RESULTANT CURRENT IS 1.88 CM/S AT 95. DEG. FROM MAG. NORTH
 MEAN CURRENT IS 10.32 CM/S
 MAXIMUM CURRENT IS 28.90 CM/S
 MINIMUM CURRENT IS 1.50 CM/S

TOTAL NO. OF POINTS 2880
 PERSISTANCE IS 0.18
 READINGS TAKEN EVERY 15.0 MINS.

METER OPERATIONS

METER OPERATED AT 6.1 M FROM BOTTOM IN 8.8 M OF WATER

STARTED AT 0.06 HRS. ON 1 TH DAY OF JUN 1983
 ENDED AT 23.51 HRS. ON 30 TH DAY OF JUN 1983

TABLE 1.13

LOCATION CODE : 1409
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR

PERIOD : JUL 1983
 LATITUDE : 48 20 49 N
 LONGITUDE : 89 11 22 W

ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

		DIRECTION					IN DEGREES				
SPEED(CM/S)		337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW SUMS	
1.50	--	4.99	4.15	2.31	1.90	0.77	2.07	2.73	1.84	2.19	17.95
5.00	--	7.99	3.14	3.02	2.07	1.48	3.32	5.27	2.84	2.25	23.40
8.00	--	10.99	3.97	2.07	0.24	1.54	7.29	5.92	1.30	1.54	23.87
11.00	--	13.99	2.84	2.43	0.18	0.65	7.76	5.04	0.83	0.59	20.32
14.00	--	16.99	1.95	2.55	0.06	0.06	2.43	1.18	0.00	0.18	8.41
17.00	--	19.99	0.89	0.89	0.00	0.00	0.24	0.18	0.00	0.06	2.25
20.00	--	22.99	1.54	0.77	0.00	0.00	0.00	0.00	0.00	0.00	2.31
23.00	--	27.30	0.89	0.59	0.00	0.00	0.00	0.00	0.00	0.00	1.48
COLUMN SUMS		19.37	14.63	4.44	4.50	23.10	20.32	6.81	6.81	100.00	

RESULTANT CURRENT IS 0.48 CM/S AT 225. DEG. FROM MAG. NORTH
 MEAN CURRENT IS 9.35 CM/S
 MAXIMUM CURRENT IS 27.30 CM/S
 MINIMUM CURRENT IS 1.50 CM/S

TOTAL NO. OF POINTS 1688
 PERSISTANCE IS 0.05
 READINGS TAKEN EVERY 15.0 MINS.

METER OPERATIONS

METER OPERATED AT 6.1 M FROM BOTTOM IN 8.8 M OF WATER

STARTED AT 0.06 HRS. ON 1 TH DAY OF JUL 1983
 ENDED AT 13.51 HRS. ON 18 TH DAY OF JUL 1983

TABLE 1.14

LOCATION CODE : 1409
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR

PERIOD : AUG 1983
 LATITUDE : 48 20 49 N
 LONGITUDE: 89 11 22 W

ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

		DIRECTION				IN DEGREES					
SPEED(CM/S)		337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW	SUMS
1.50	-- 3.99	1.04	1.08	0.97	0.87	3.29	3.93	1.98	1.75	14.92	
4.00	-- 6.99	1.88	1.18	0.81	0.91	3.90	2.18	1.65	2.02	14.52	
7.00	-- 9.99	3.60	2.42	1.08	1.65	6.28	5.85	1.34	2.35	24.56	
10.00	-- 12.99	2.89	2.99	1.41	1.48	6.05	4.57	1.08	1.28	21.74	
13.00	-- 15.99	2.92	1.78	0.40	0.64	4.40	2.76	0.34	0.47	13.71	
16.00	-- 18.99	1.71	0.91	0.00	0.20	2.15	1.04	0.00	0.00	6.01	
19.00	-- 21.99	0.84	0.64	0.03	0.24	1.18	0.94	0.00	0.00	3.86	
22.00	-- 22.80	0.03	0.03	0.00	0.10	0.20	0.30	0.00	0.00	0.67	
COLUMN SUMS		14.92	11.02	4.70	6.08	27.45	21.57	6.38	7.86	100.00	

RESULTANT CURRENT IS 1.91 CM/S AT 198. DEG. FROM MAG. NORTH
 MEAN CURRENT IS 9.72 CM/S
 MAXIMUM CURRENT IS 22.80 CM/S
 MINIMUM CURRENT IS 1.50 CM/S

TOTAL NO. OF POINTS 2976
 PERSISTANCE IS 0.20
 READINGS TAKEN EVERY 15.0 MINS.

METER OPERATIONS

METER OPERATED AT 6.1 M FROM BOTTOM IN 8.8 M OF WATER

STARTED AT 0.13 HRS. ON 1 TH DAY OF AUG 1983
 ENDED AT 23.58 HRS. ON 31 TH DAY OF AUG 1983

TABLE 1.15

LOCATION CODE : 1409
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR

PERIOD : SEP 1983
 LATITUDE : 48 20 49 N
 LONGITUDE: 89 11 22 W

ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

			DIRECTION				IN DEGREES					
SPEED(CM/S)			337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW	SUMS
1.50	--	3.99	2.57	2.94	5.57	6.95	3.38	2.07	3.76	5.89	33.12	
4.00	--	6.99	1.31	1.50	3.51	4.95	3.32	2.25	1.38	4.45	22.67	
7.00	---	9.99	0.50	1.75	2.82	1.57	3.69	2.25	1.00	0.81	14.40	
10.00	--	12.99	0.69	2.25	1.19	1.38	2.94	5.95	1.50	0.81	16.72	
13.00	--	15.99	0.75	0.38	0.00	0.13	2.50	3.32	0.13	0.00	7.20	
16.00	--	18.99	0.44	0.00	0.00	0.00	2.07	1.50	0.00	0.00	4.01	
19.00	--	21.99	0.00	0.00	0.00	0.00	0.56	0.50	0.00	0.00	1.06	
22.00	--	22.70	0.00	0.00	0.00	0.00	0.69	0.13	0.00	0.00	0.81	
COLUMN SUMS			6.26	8.83	13.09	14.97	19.16	17.97	7.76	11.96	100.00	

RESULTANT CURRENT IS 2.62 CM/S AT 194. DEG. FROM MAG. NORTH
 MEAN CURRENT IS 7.26 CM/S
 MAXIMUM CURRENT IS 22.70 CM/S
 MINIMUM CURRENT IS 1.50 CM/S

TOTAL NO. OF POINTS 1597
 PERSISTANCE IS 0.36
 READINGS TAKEN EVERY 15.0 MINS.

METER OPERATIONS

METER OPERATED AT 6.1 M FROM BOTTOM IN 8.8 M OF WATER

STARTED AT 0.13 HRS. ON 1 TH DAY OF SEP 1983
 ENDED AT 15.13 HRS. ON 17 TH DAY OF SEP 1983

TABLE 1.16

LOCATION CODE : 1410
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR

PERIOD : MAY 1983
 LATITUDE : 48 19 2 N
 LONGITUDE : 89 11 13 W

ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

		DIRECTION					IN DEGREES				
SPEED(CM/S)		337.50-	22.50-	67.50-	112.50-	157.50-	202.50-	247.50-	292.50-		
		22.49	67.49	112.49	157.49	202.49	247.49	292.49	337.49	ROW SUMS	
1.50 --	4.99	6.46	3.32	2.11	4.35	6.33	4.73	1.28	3.20	31.78	
5.00 --	8.99	6.46	3.52	0.70	0.83	6.78	1.28	0.38	1.15	21.10	
9.00 --	12.99	4.92	0.96	0.06	0.19	6.84	0.19	0.00	0.45	13.62	
13.00 --	16.99	3.96	0.00	0.00	0.26	11.83	0.00	0.00	0.00	16.05	
17.00 --	20.99	1.66	0.00	0.00	0.00	9.34	0.00	0.00	0.00	11.00	
21.00 --	24.99	0.51	0.00	0.00	0.00	3.71	0.00	0.00	0.00	4.22	
25.00 --	28.99	0.00	0.00	0.00	0.00	1.73	0.00	0.00	0.00	1.73	
29.00 --	31.40	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.51	
COLUMN SUMS		23.98	7.80	2.88	5.63	47.06	6.20	1.66	4.80	100.00	

RESULTANT CURRENT IS 4.10 CM/S AT 172. DEG. FROM MAG. NORTH
 MEAN CURRENT IS 9.83 CM/S
 MAXIMUM CURRENT IS 31.40 CM/S
 MINIMUM CURRENT IS 1.50 CM/S

TOTAL NO. OF POINTS 1564
 PERSISTANCE IS 0.42
 READINGS TAKEN EVERY 15.0 MINS.

METER OPERATIONS

METER OPERATED AT 8.5 M FROM BOTTOM IN 12.5 M OF WATER

STARTED AT 17.00 HRS. ON 15 TH DAY OF MAY 1983
 ENDED AT 23.45 HRS. ON 31 TH DAY OF MAY 1983

TABLE 1.17

LOCATION CODE : 1410

PERIOD : JUN 1983

AREA : THUNDER BAY

LATITUDE : 48 24 8 N

LAKE : L. SUPERIOR

LONGITUDE: 89 11 41 W

ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

		DIRECTION					IN DEGREES			
SPEED(CM/S)		337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW SUMS
1.50 --	1.99	18.68	7.26	2.05	3.65	14.79	7.36	5.38	15.76	74.93
2.00 --	2.99	3.16	1.01	0.10	0.76	2.43	0.35	0.03	0.69	8.54
3.00 --	3.99	1.88	0.38	0.07	0.38	2.15	0.10	0.00	0.28	5.24
4.00 --	4.99	0.59	0.00	0.00	0.07	1.39	0.00	0.00	0.28	2.33
5.00 --	5.99	0.14	0.00	0.00	0.03	1.18	0.07	0.03	0.14	1.60
6.00 --	6.99	0.00	0.00	0.00	0.00	1.32	0.03	0.00	0.10	1.46
7.00 --	7.99	0.14	0.00	0.00	0.03	1.15	0.00	0.00	0.03	1.35
8.00 --	13.90	0.69	0.00	0.00	0.03	3.78	0.00	0.00	0.03	4.55
COLUMN SUMS		25.28	8.65	2.22	4.97	28.19	7.92	5.45	17.33	100.00

RESULTANT CURRENT IS 0.37 CM/S AT 203. DEG. FROM MAG. NORTH

TOTAL NO. OF POINTS 2880

MEAN CURRENT IS 2.40 CM/S

PERSISTANCE IS 0.15

MAXIMUM CURRENT IS 13.90 CM/S

READINGS TAKEN EVERY 15.0 MINS.

MINIMUM CURRENT IS 1.50 CM/S

METER OPERATIONS

METER OPERATED AT 6.1 M FROM BOTTOM IN 8.8 M OF WATER

STARTED AT 0.00 HRS. ON 1 TH DAY OF JUN 1983

ENDED AT 23.45 HRS. ON 30 TH DAY OF JUN 1983

TABLE 1.18

LOCATION CODE : 1410
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR

PERIOD : JUL 1983
 LATITUDE : 48 24 8 N
 LONGITUDE: 89 11 41 W

ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

		DIRECTION					IN DEGREES				
SPEED(CM/S)		337.50-	22.50-	67.50-	112.50-	157.50-	202.50-	247.50-	292.50-	ROW SUMS	
		22.49	67.49	112.49	157.49	202.49	247.49	292.49	337.49		
1.50 --	3.99	14.61	10.61	2.11	8.35	28.40	12.05	5.14	9.48	90.75	
4.00 --	5.99	1.02	1.06	0.11	0.11	0.38	0.11	0.34	0.60	3.74	
6.00 --	7.99	0.57	0.34	0.08	0.00	0.26	0.08	0.00	0.11	1.44	
8.00 --	9.99	0.53	0.19	0.00	0.04	0.08	0.00	0.04	0.00	0.87	
10.00 --	11.99	0.72	0.04	0.00	0.00	0.30	0.08	0.00	0.04	1.17	
12.00 --	13.99	0.57	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.98	
14.00 --	15.99	0.04	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.57	
16.00 --	16.80	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.49	
COLUMN SUMS		18.05	12.24	2.30	8.50	30.85	12.31	5.51	10.23	100.00	

RESULTANT CURRENT IS 0.04 CM/S AT 209. DEG. FROM MAG. NORTH
 MEAN CURRENT IS 2.32 CM/S
 MAXIMUM CURRENT IS 16.80 CM/S
 MINIMUM CURRENT IS 1.50 CM/S

TOTAL NO. OF POINTS 2648
 PERSISTANCE IS 0.02
 READINGS TAKEN EVERY 15.0 MINS.

METER OPERATIONS

METER OPERATED AT 6.1 M FROM BOTTOM IN 8.8 M OF WATER

STARTED AT 0.00 HRS. ON 1 TH DAY OF JUL 1983
 ENDED AT 13.45 HRS. ON 28 TH DAY OF JUL 1983

TABLE 1.19

LOCATION CODE : 1410
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR
 PERIOD : AUG 1983
 LATITUDE : 48 19 2 N
 LONGITUDE : 89 11 13 W
 ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

		DIRECTION					IN DEGREES				
SPEED(CM/S)		337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW SUMS	
1.50	-- 4.99	2.05	1.08	1.04	2.92	3.66	8.03	4.94	5.07	28.80	
5.00	-- 7.99	4.30	2.92	1.41	3.16	4.00	3.63	1.61	3.16	24.19	
8.00	-- 10.99	5.11	2.35	0.47	1.14	6.52	1.81	0.10	1.81	19.32	
11.00	-- 13.99	3.33	1.44	0.17	0.27	6.15	0.74	0.07	0.57	12.74	
14.00	-- 16.99	1.08	0.77	0.00	0.17	5.28	0.13	0.00	0.10	7.53	
17.00	-- 19.99	0.74	0.17	0.00	0.13	4.10	0.07	0.00	0.00	5.21	
20.00	-- 22.99	0.03	0.13	0.00	0.03	1.71	0.03	0.00	0.00	1.95	
23.00	-- 25.00	0.00	0.10	0.00	0.00	0.17	0.00	0.00	0.00	0.27	
COLUMN SUMS		16.63	8.97	3.09	7.83	31.59	14.45	6.72	10.72	100.00	

RESULTANT CURRENT IS 2.03 CM/S AT 186. DEG. FROM MAG. NORTH
 MEAN CURRENT IS 8.41 CM/S
 MAXIMUM CURRENT IS 25.00 CM/S
 MINIMUM CURRENT IS 1.50 CM/S
 TOTAL NO. OF POINTS 2976
 PERSISTENCE IS 0.24
 READINGS TAKEN EVERY 15.0 MINS.

METER OPERATIONS

METER OPERATED AT 8.5 M FROM BOTTOM IN 12.5 M OF WATER

STARTED AT 0.01 HRS. ON 1 TH DAY OF AUG 1983
 ENDED AT 23.46 HRS. ON 31 TH DAY OF AUG 1983

TABLE 1.20

LOCATION CODE : 1410
 AREA : THUNDER BAY
 LAKE : L. SUPERIOR

PERIOD : SEP 1983
 LATITUDE : 48 24 8 N
 LONGITUDE : 89 11 41 W

ANGLE FROM MAGNETIC NORTH TO SHORELINE IS 0 DEGREES CLOCKWISE

FREQUENCY TABLE

		DIRECTION					IN DEGREES				
SPEED(CM/S)		337.50- 22.49	22.50- 67.49	67.50- 112.49	112.50- 157.49	157.50- 202.49	202.50- 247.49	247.50- 292.49	292.50- 337.49	ROW SUMS	
1.50	--	3.99	1.87	1.69	0.75	1.19	2.75	2.00	2.81	4.00	17.05
4.00	--	6.99	5.75	3.31	2.94	2.94	3.37	3.62	2.75	3.81	28.48
7.00	--	9.99	2.44	2.75	1.12	2.50	10.74	1.62	0.37	2.56	24.11
10.00	--	12.99	1.69	1.19	0.00	0.75	8.37	0.50	0.00	0.31	12.80
13.00	--	15.99	0.31	0.62	0.00	0.19	5.87	0.50	0.00	0.00	7.50
16.00	--	18.99	0.00	0.62	0.00	0.00	5.43	0.62	0.00	0.00	6.68
19.00	--	21.99	0.00	0.06	0.00	0.00	2.81	0.12	0.00	0.00	3.00
22.00	--	22.80	0.00	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.37
COLUMN SUMS		12.05	10.24	4.81	7.56	39.73	8.99	5.93	10.68	100.00	

RESULTANT CURRENT IS 3.65 CM/S AT 179. DEG. FROM MAG. NORTH
 MEAN CURRENT IS 8.45 CM/S
 MAXIMUM CURRENT IS 22.80 CM/S
 MINIMUM CURRENT IS 1.50 CM/S

TOTAL NO. OF POINTS 1601
 PERSISTANCE IS 0.43
 READINGS TAKEN EVERY 15.0 MINS.

METER OPERATIONS

METER OPERATED AT 6.1 M FROM BOTTOM IN 8.8 M OF WATER

STARTED AT 0.01 HRS. ON 1 TH DAY OF SEP 1983
 ENDED AT 16.01 HRS. ON 17 TH DAY OF SEP 1983

TABLE 2.01: Temperature Frequency,
Thunder Bay, Lake Superior, 1983

Location # 1407

Temperature Range °C	May	June	July	Aug.	Sept.
0.0 - 0.9		10.17	9.32	4.77	3.79
1.0 - 1.9		6.63	14.78	4.47	11.99
2.0 - 2.9		6.04	15.92	2.49	7.00
3.0 - 3.9	10.18	10.80	17.36	2.99	0.38
4.0 - 4.9	10.84	6.15	10.69	6.89	2.40
5.0 - 5.9	55.87	14.44	8.15	11.46	4.48
6.0 - 6.9	23.11	19.97	5.23	11.83	16.40
7.0 - 7.9		17.19	1.86	22.08	23.41
8.0 - 8.9		5.49	6.86	21.00	17.92
9.0 - 9.7		3.13	9.85	12.03	12.24
Total	100.00	100.00	100.00	100.00	100.00
Monthly Mean °C	5.32	5.06	4.13	6.50	6.21
Monthly Std. Dev. °C	0.83	2.54	2.75	2.46	2.80

TABLE 2.02: Temperature Frequency,
Thunder Bay, Lake Superior, 1983

Location # 1408

Temperature Range °C	May	June	July	Aug.	Sept.
0.0 - 0.9		4.37	6.39	3.33	9.66
1.0 - 1.9		5.52	11.41	4.33	21.07
2.0 - 2.9		6.11	24.57	4.97	5.89
3.0 - 3.9	1.56	11.98	12.51	5.44	2.70
4.0 - 4.9	6.12	5.69	9.52	6.85	2.38
5.0 - 5.9	17.41	5.56	8.88	11.53	7.90
6.0 - 6.9	22.15	11.67	7.11	22.28	15.30
7.0 - 7.9	29.95	18.61	7.37	19.69	8.84
8.0 - 8.9	4.02	23.61	7.26	14.85	17.74
9.0 - 9.7	18.79	6.87	4.99	6.72	8.53
Total	100.00	100.00	100.00	100.00	100.00
Monthly Mean °C	7.13	6.01	4.22	6.11	5.08
Monthly Std. Dev. °C	1.65	2.60	2.55	2.27	3.11

TABLE 2.03: Temperature Frequency,
Thunder Bay, Lake Superior, 1983

Location # 1409

Temperature Range °C	May	June	July	Aug.	Sept.
0.0 - 0.9	0.71	14.93	2.13	2.92	10.39
1.0 - 1.9	0.00	9.65	7.46	1.98	8.27
2.0 - 2.9	0.04	7.08	14.57	2.65	4.76
3.0 - 3.9	0.83	12.78	20.73	3.13	7.51
4.0 - 4.9	3.08	11.35	8.29	8.94	6.20
5.0 - 5.9	16.57	10.52	5.15	20.46	5.45
6.0 - 6.9	28.39	2.33	6.75	17.64	11.46
7.0 - 7.9	27.20	7.50	15.94	22.24	11.02
8.0 - 8.9	16.29	10.90	13.33	13.78	23.04
9.0 - 9.7	6.88	12.95	5.63	6.25	11.90
Total	100.00	100.00	100.00	100.00	100.00
Monthly Mean °C	6.97	4.78	5.12	6.28	5.76
Monthly Std. Dev. °C	1.38	3.10	2.56	2.03	3.05

TABLE 2.04: Temperature Frequency,
Thunder Bay, Lake Superior, 1983

Location # 1410

Temperature Range °C	May	June	July	Aug.	Sept.
0.0 - 0.9		7.36	12.42	2.12	1.87
1.0 - 1.9		3.96	16.39	3.73	5.93
2.0 - 2.9		3.75	9.89	4.17	21.55
3.0 - 3.9	3.26	6.18	9.40	6.28	19.11
4.0 - 4.9	13.04	1.49	9.48	12.23	8.62
5.0 - 5.9	25.00	3.19	9.28	21.37	11.99
6.0 - 6.9	40.60	18.51	2.76	17.71	12.93
7.0 - 7.9	18.03	16.53	14.27	17.81	10.56
8.0 - 8.9	0.06	21.53	8.19	9.51	6.81
9.0 - 9.7		17.50	7.40	5.07	0.62
Total	100.00	100.00	100.00	100.00	100.00
Monthly Mean °C	6.05	6.50	4.45	5.83	4.54
Monthly Std. Dev. °C	0.96	2.75	2.93	2.06	2.19

LOCATION - 1407 (MAY 83)

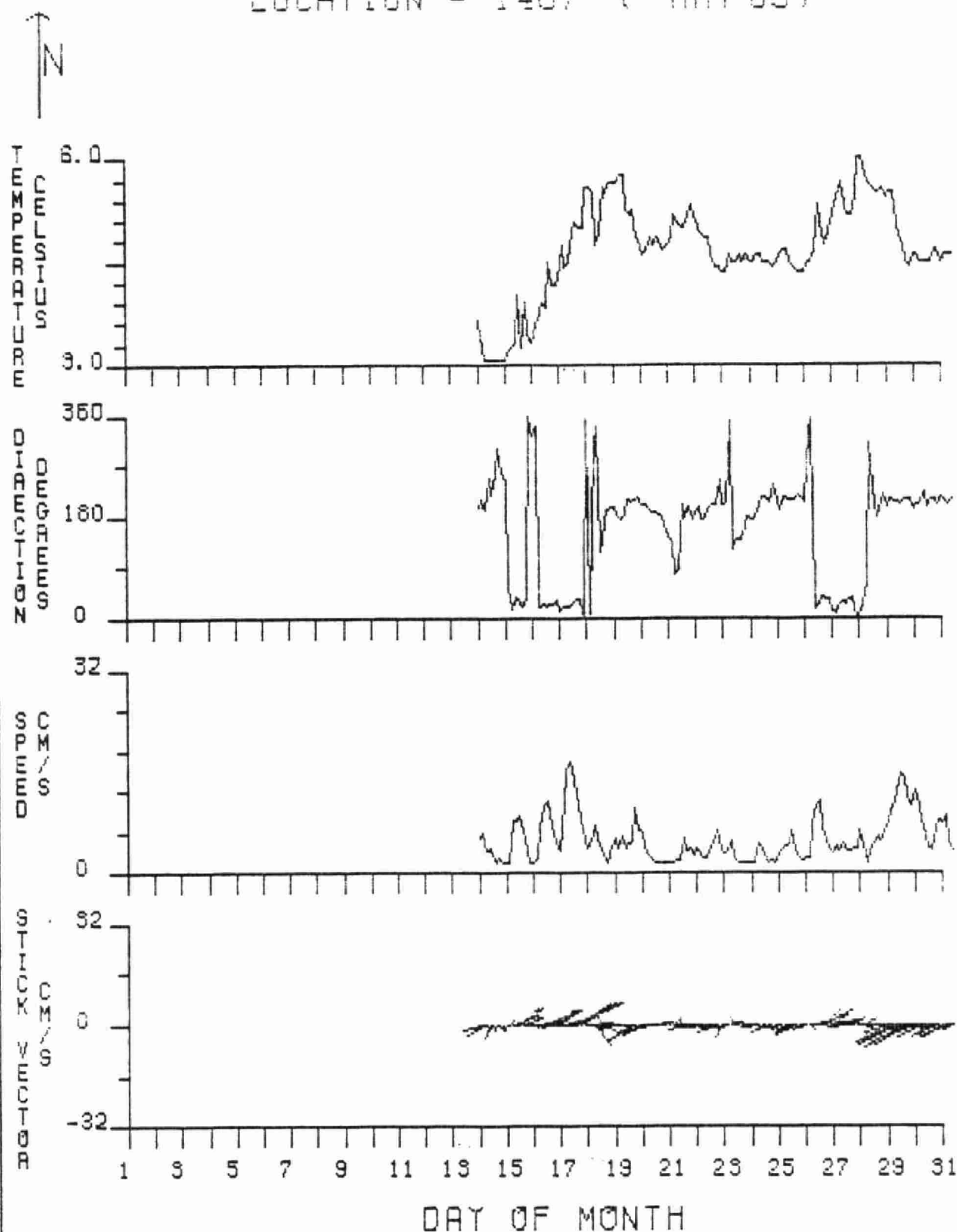


FIG. 1.01: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1407 (JUN 83)

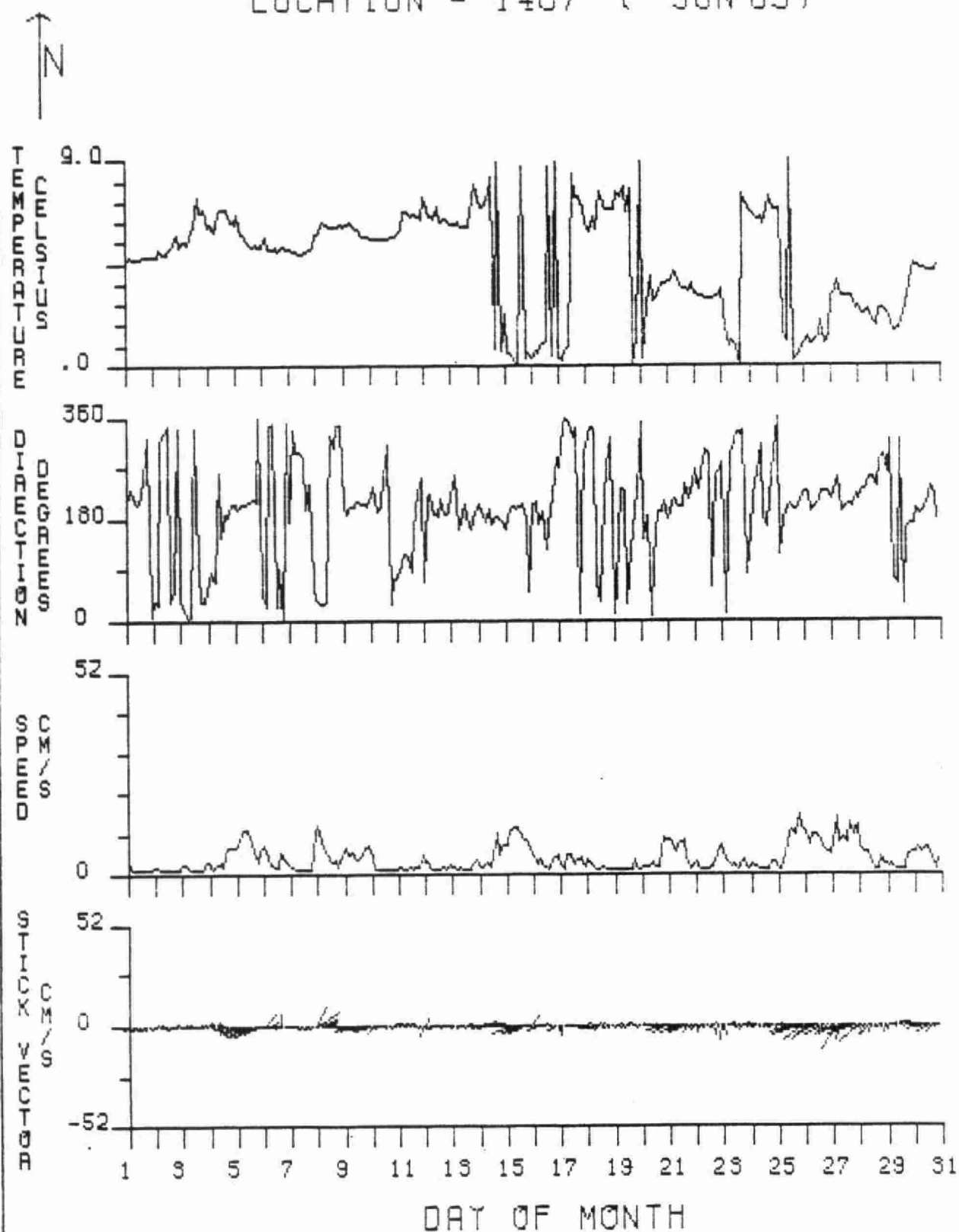


FIG.1.02 : VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1407 (JUL 83)

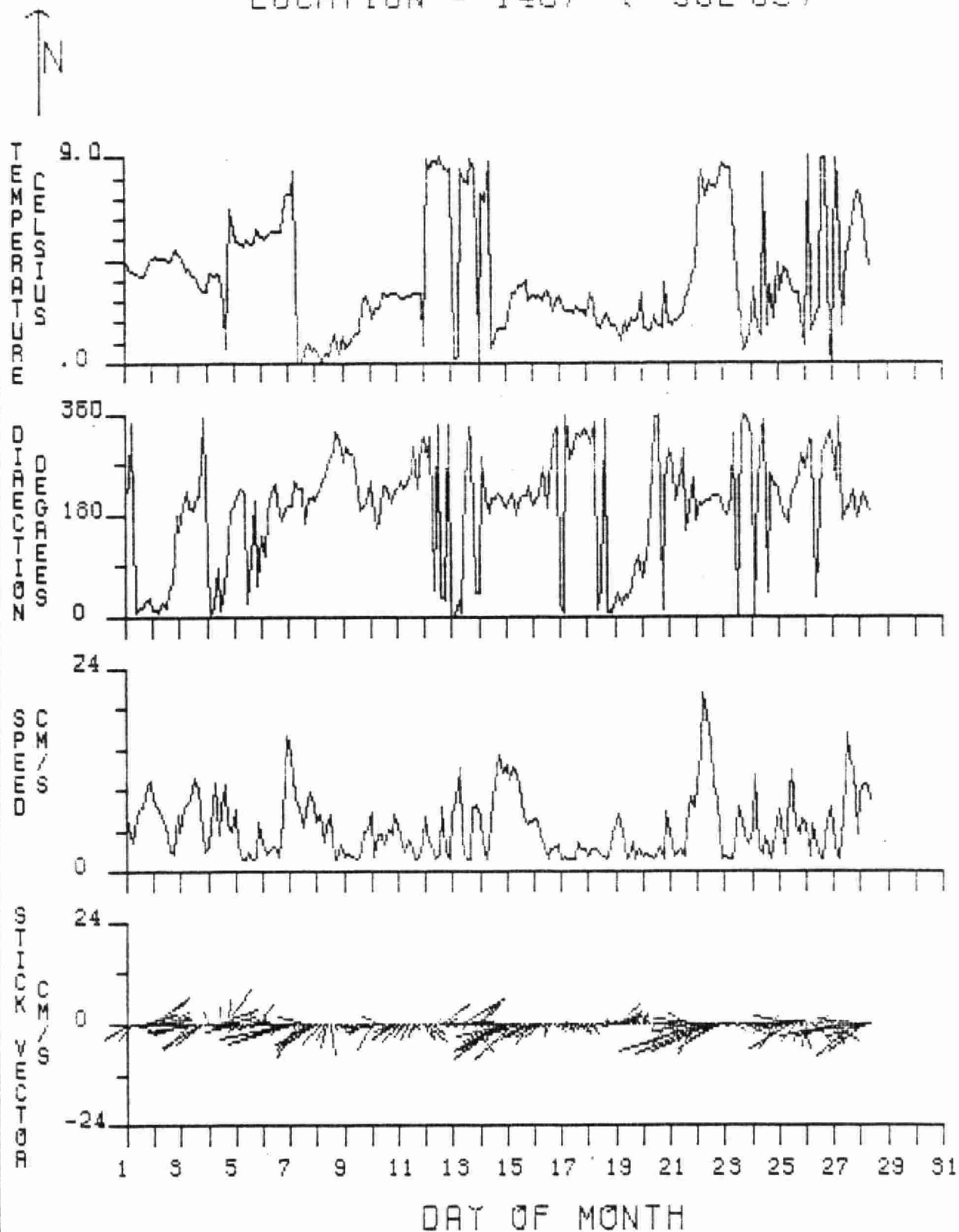


FIG.1.03 : VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1407 (AUG 83)

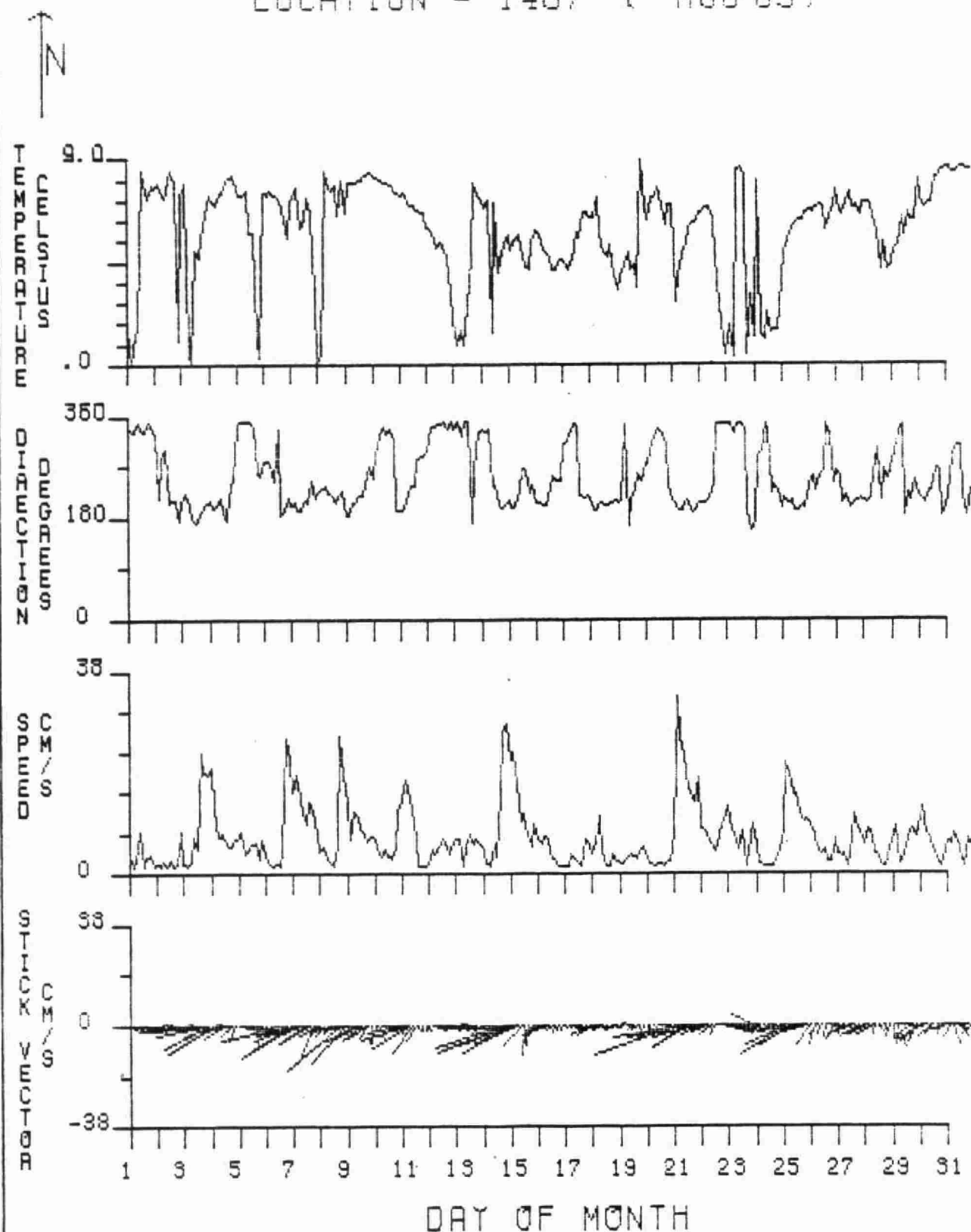


FIG.1:04: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1407 (SEP 83)

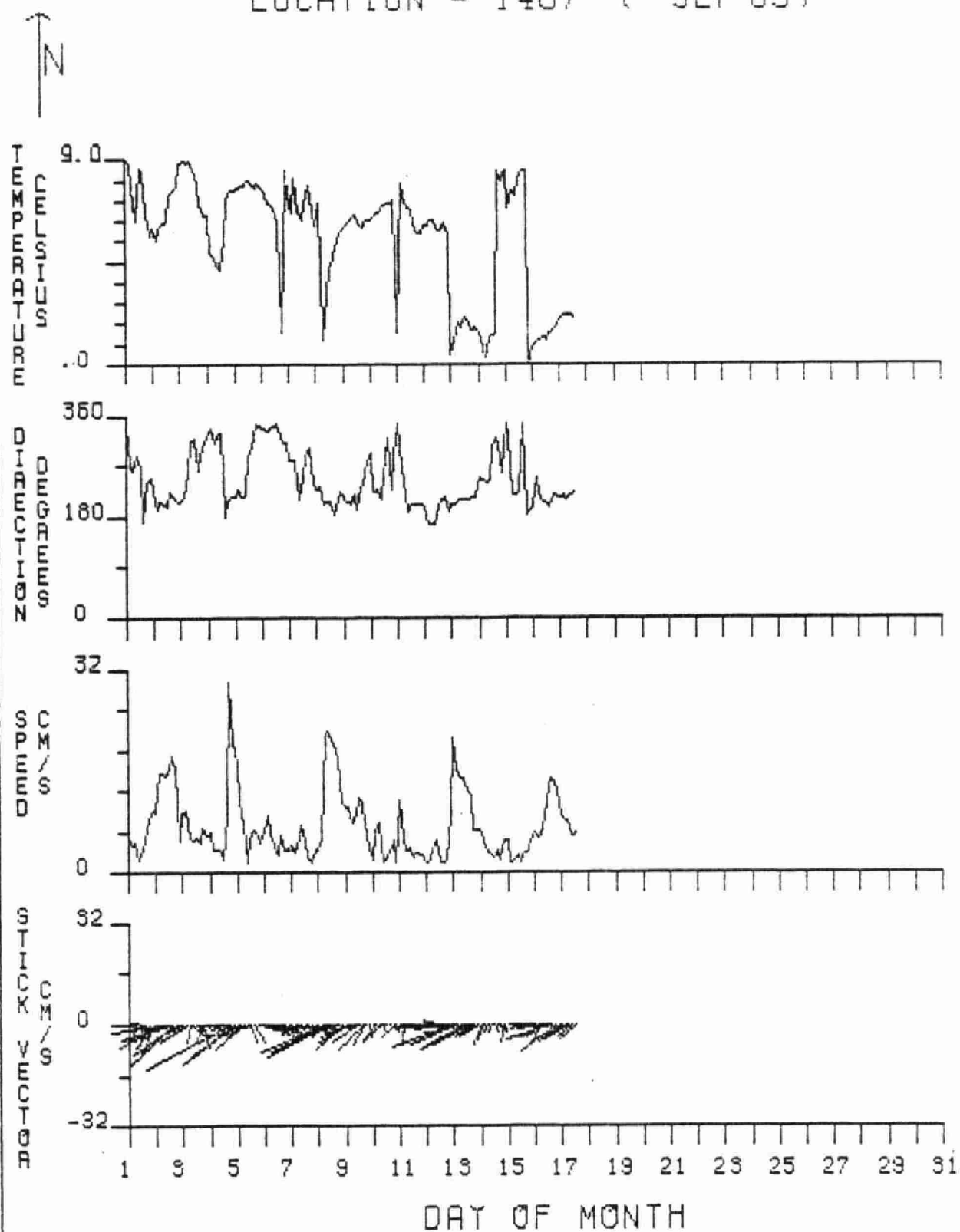


FIG. 1.05: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1408 (MAY 83)

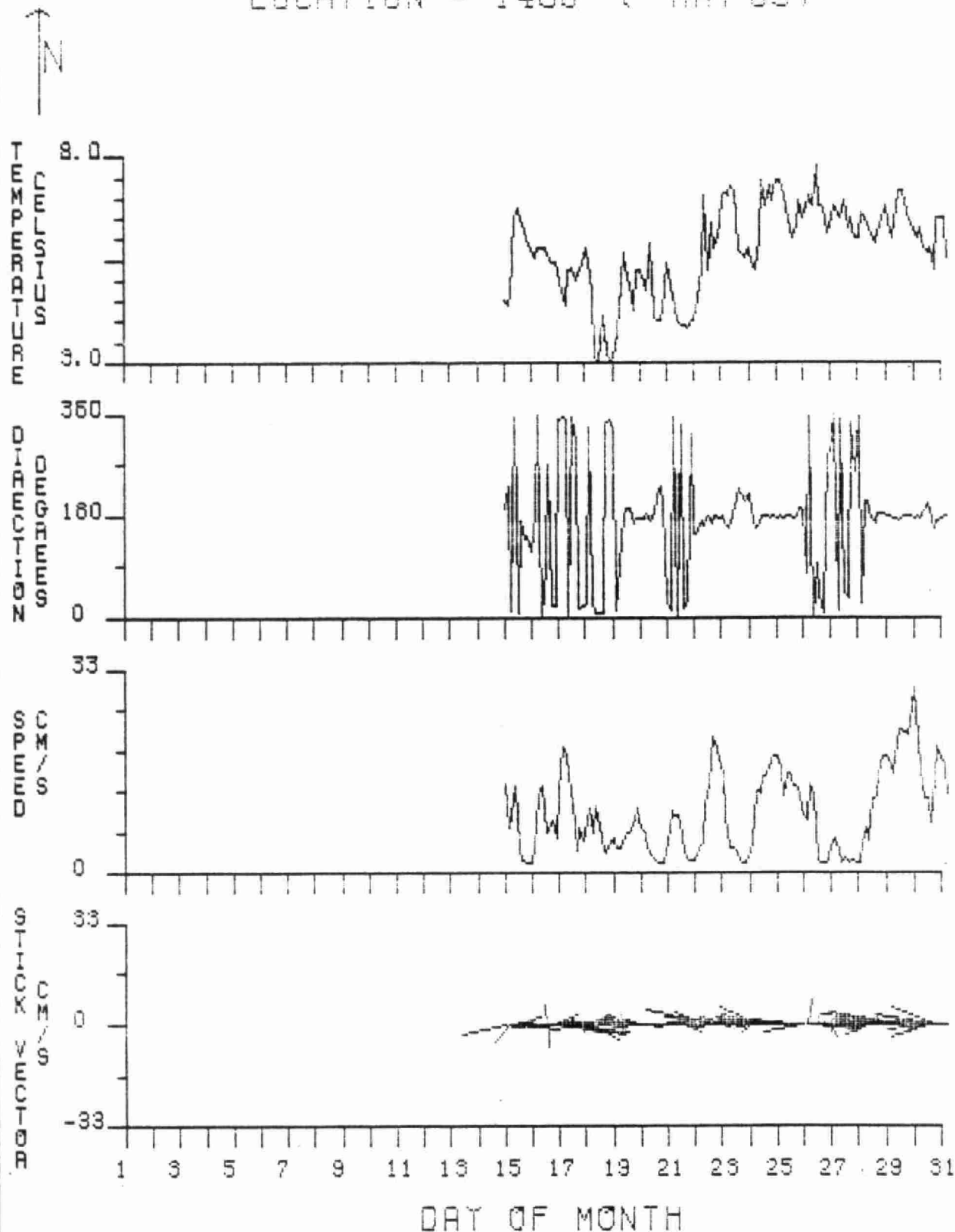


FIG.1.06: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1408 (JUN 83)

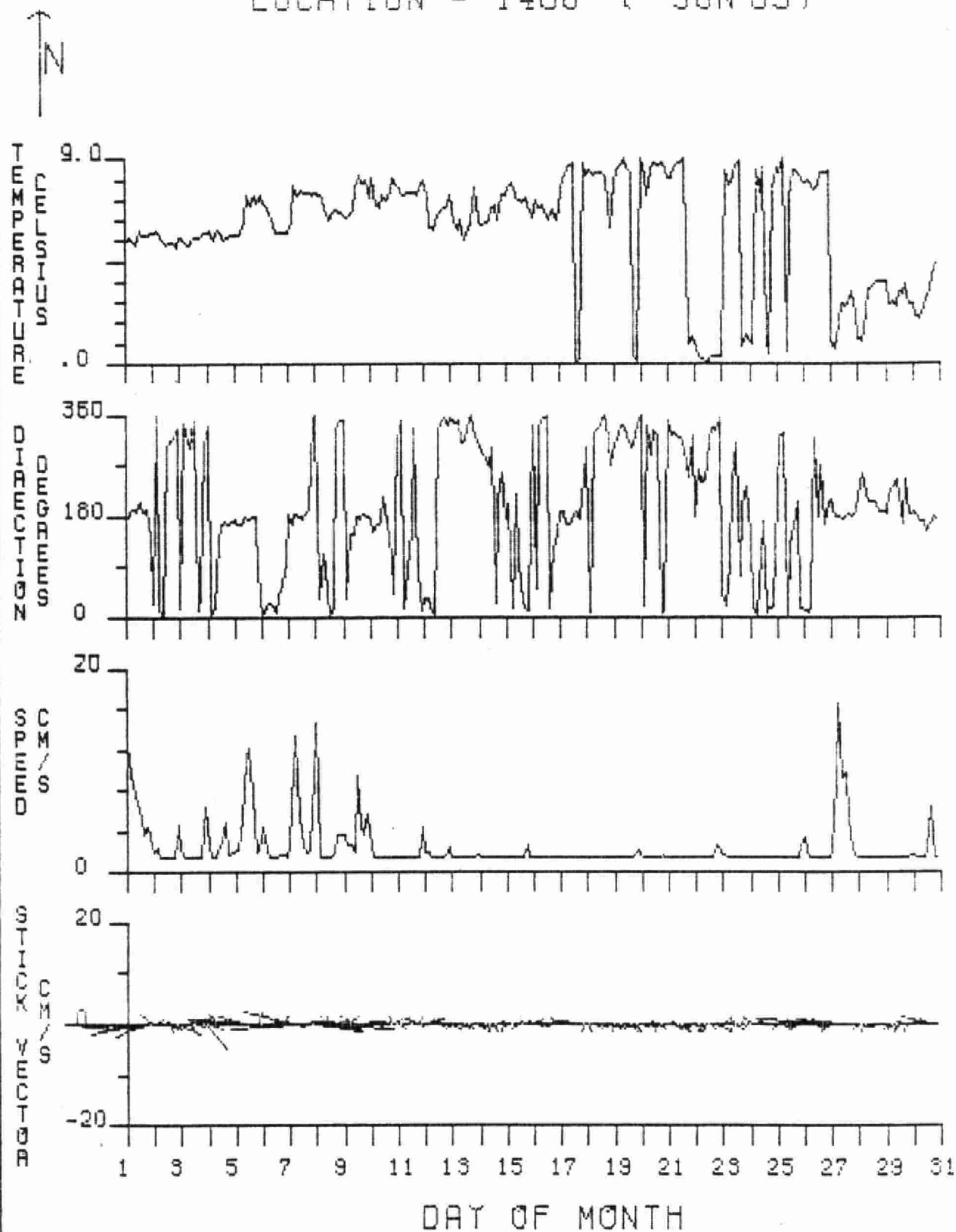


FIG. 1.07: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1408 (JUL 83)

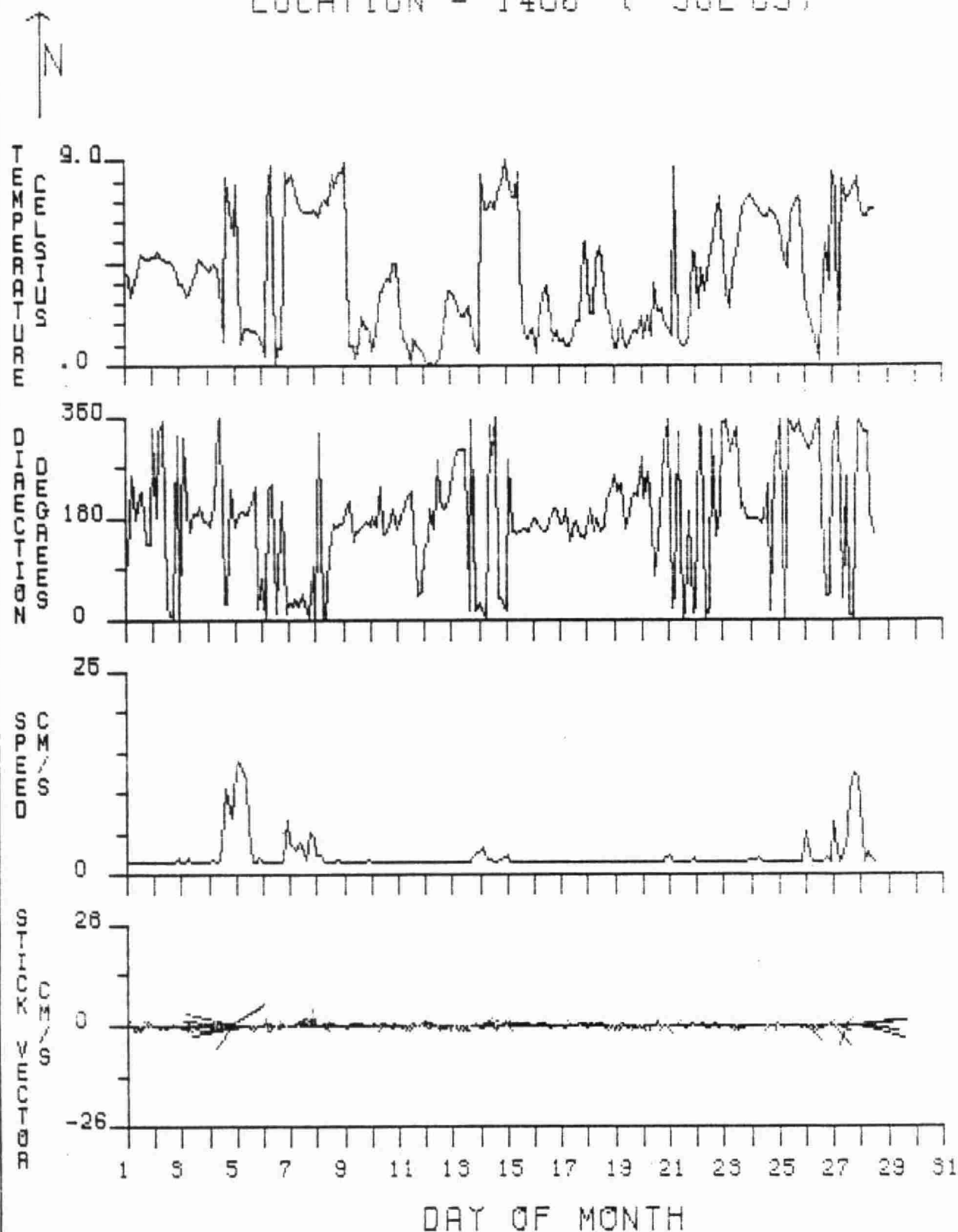


FIG.1.08: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1408 (AUG 83)

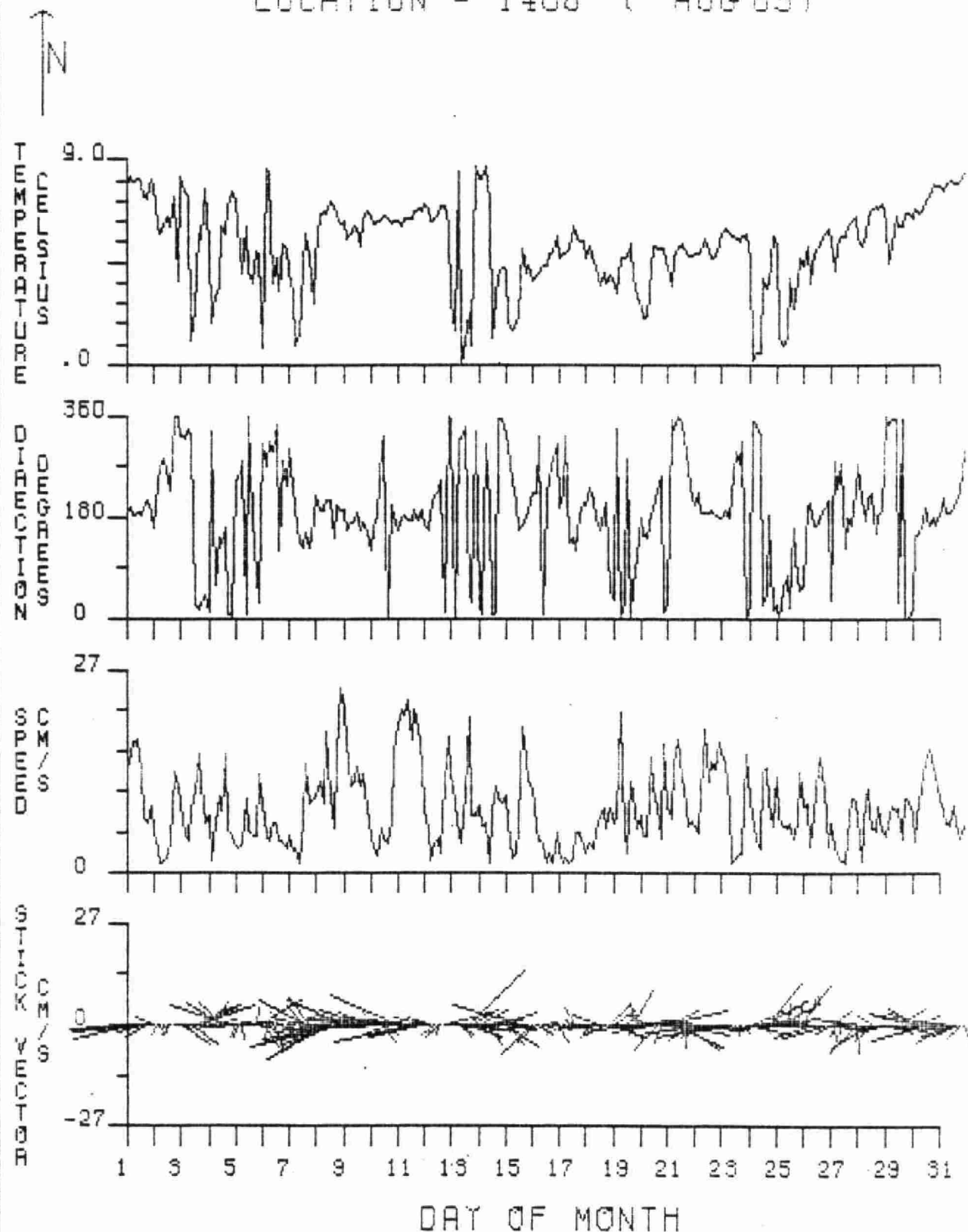


FIG. 1.09: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1408 (SEP 83)

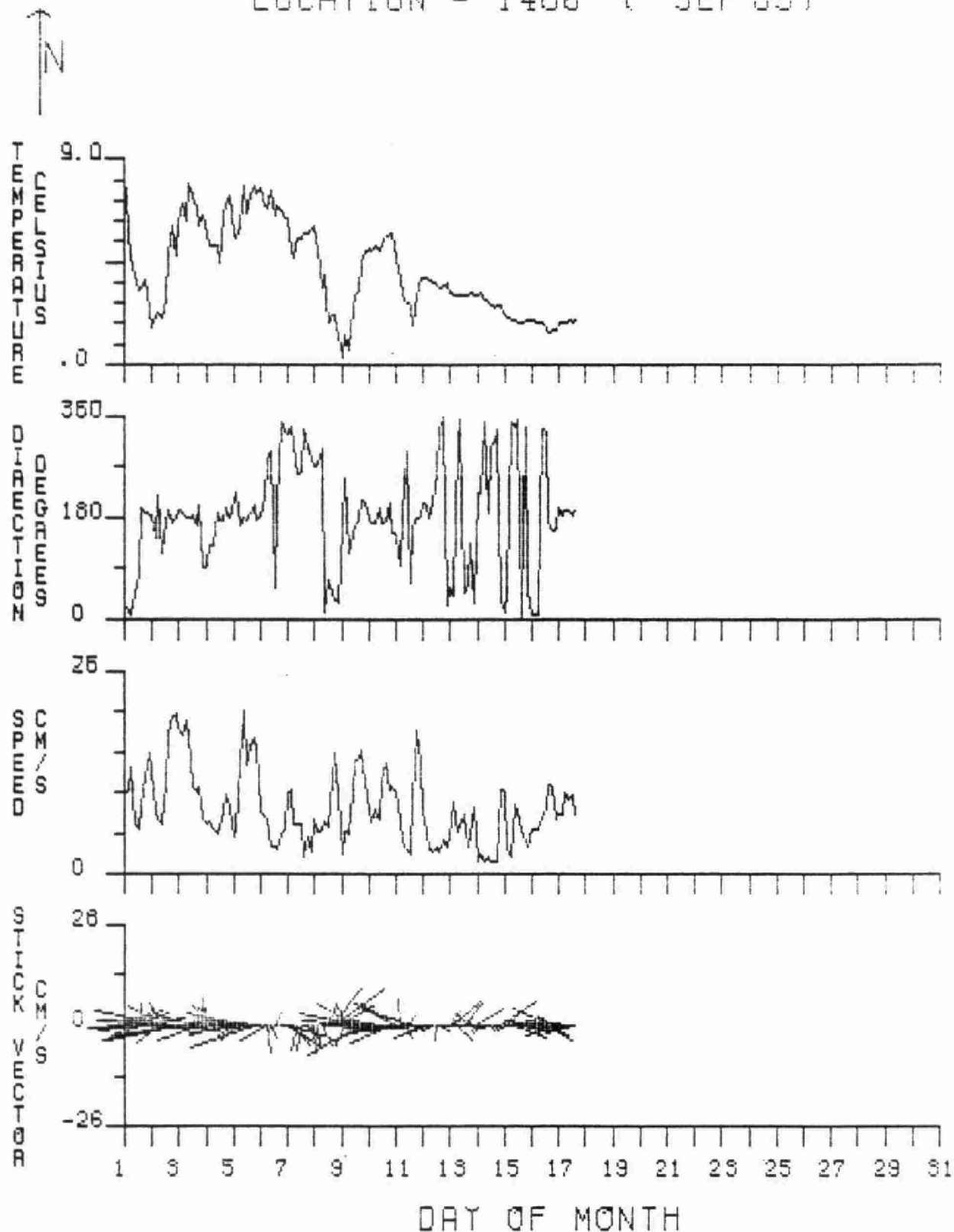


FIG. 1.10: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1409 (MAY 83)

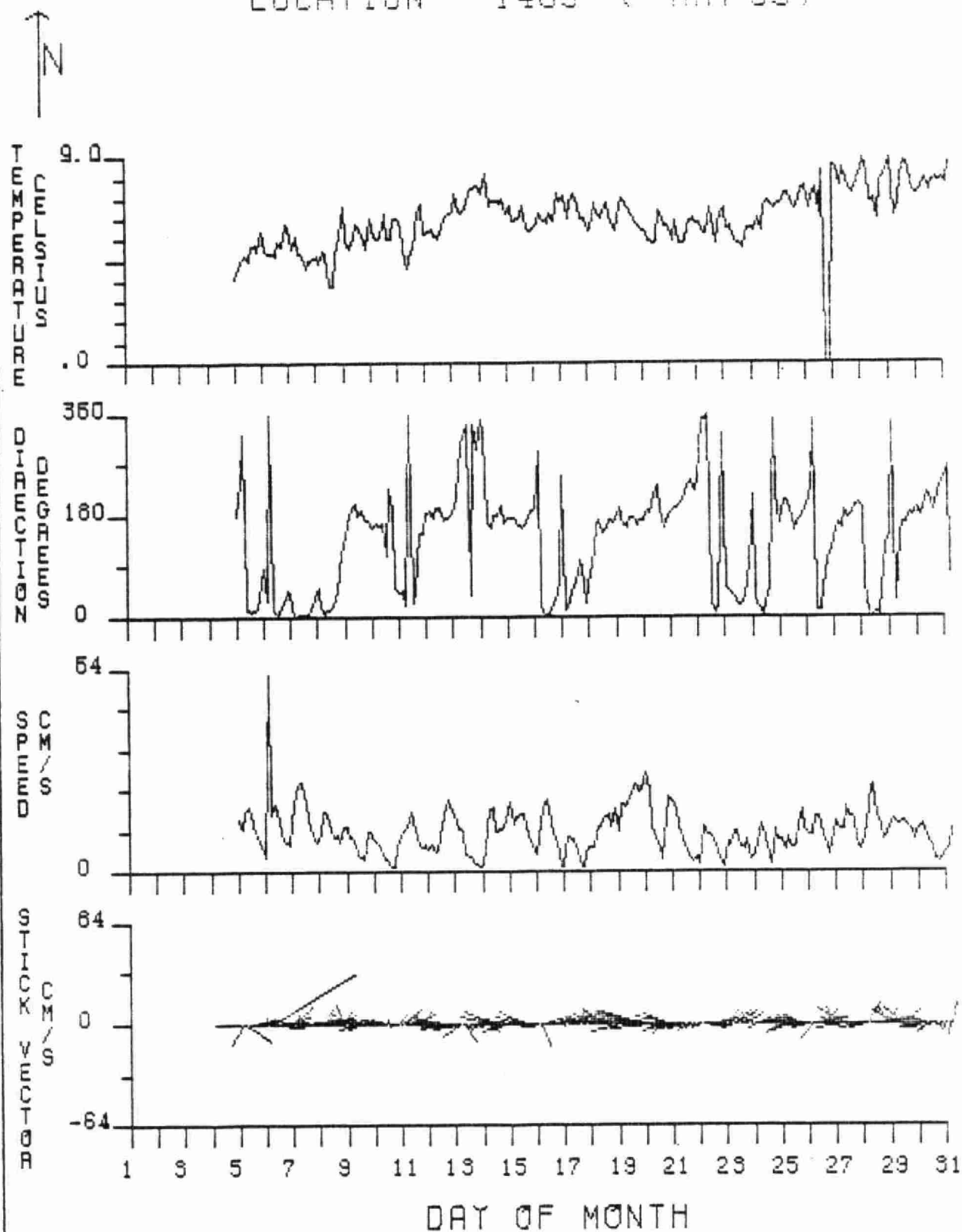


FIG. 1.11: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1409 (JUN 83)

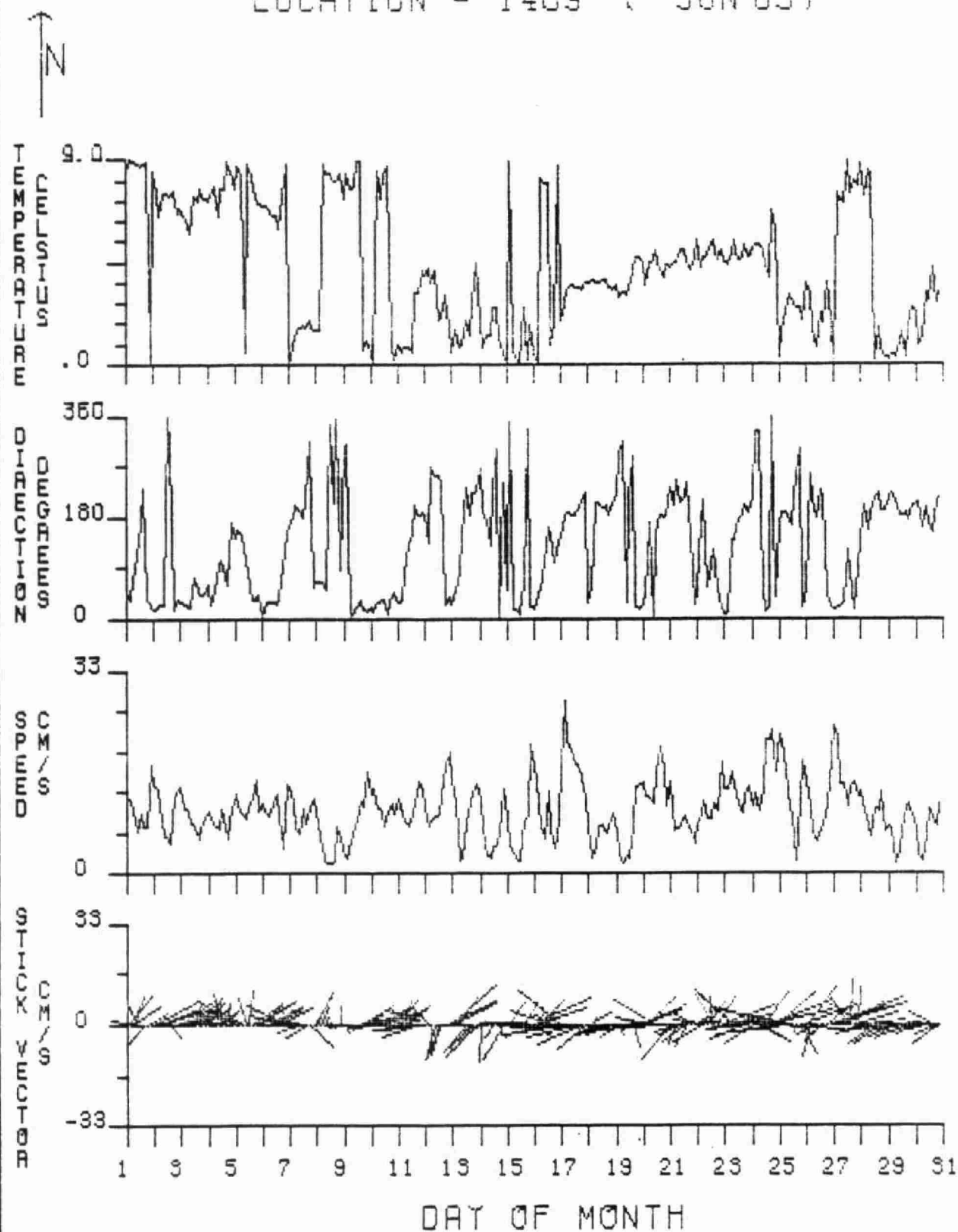


FIG.1.12: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1409 (JUL 83)

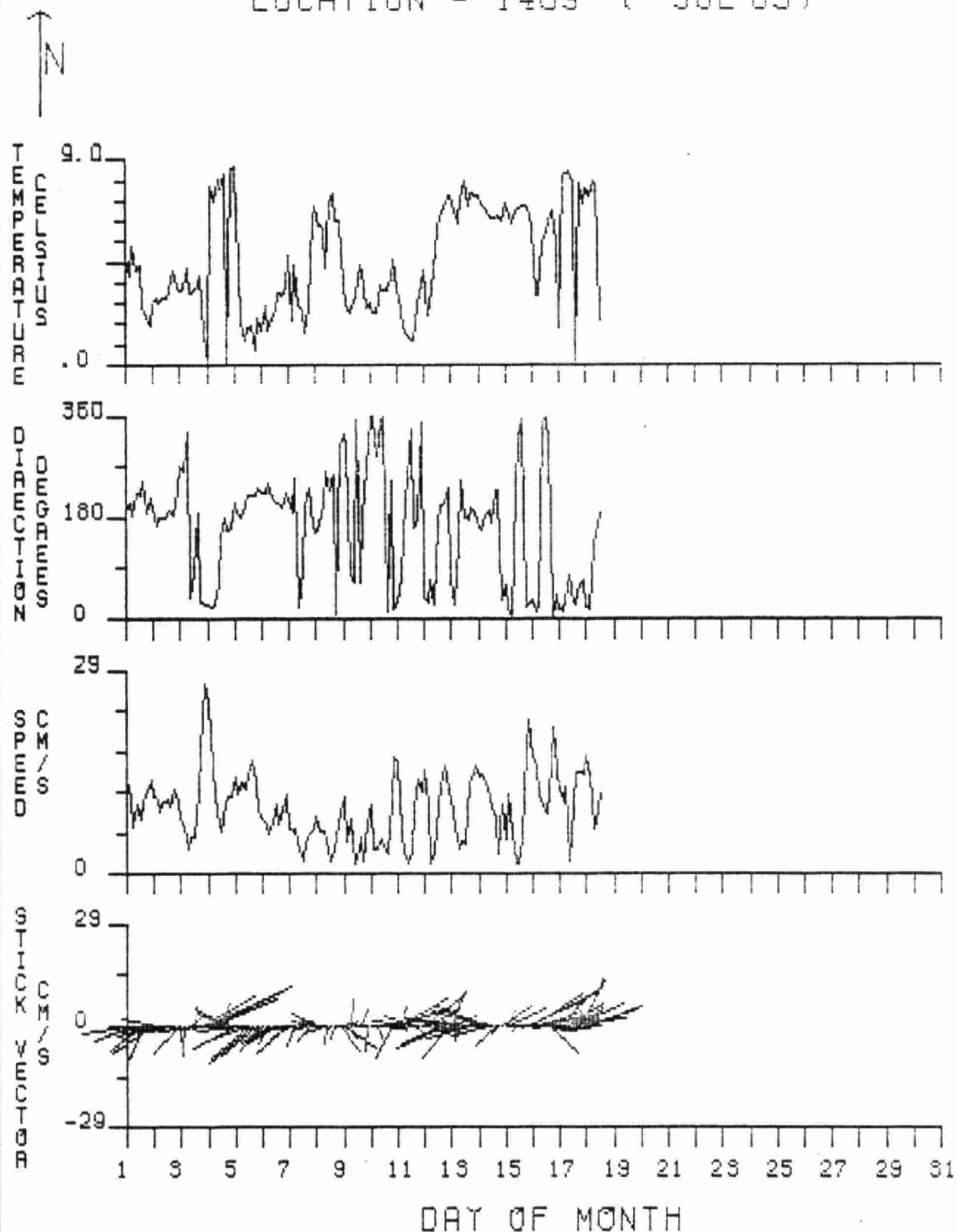


FIG. 1.13: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1409 (AUG 83)

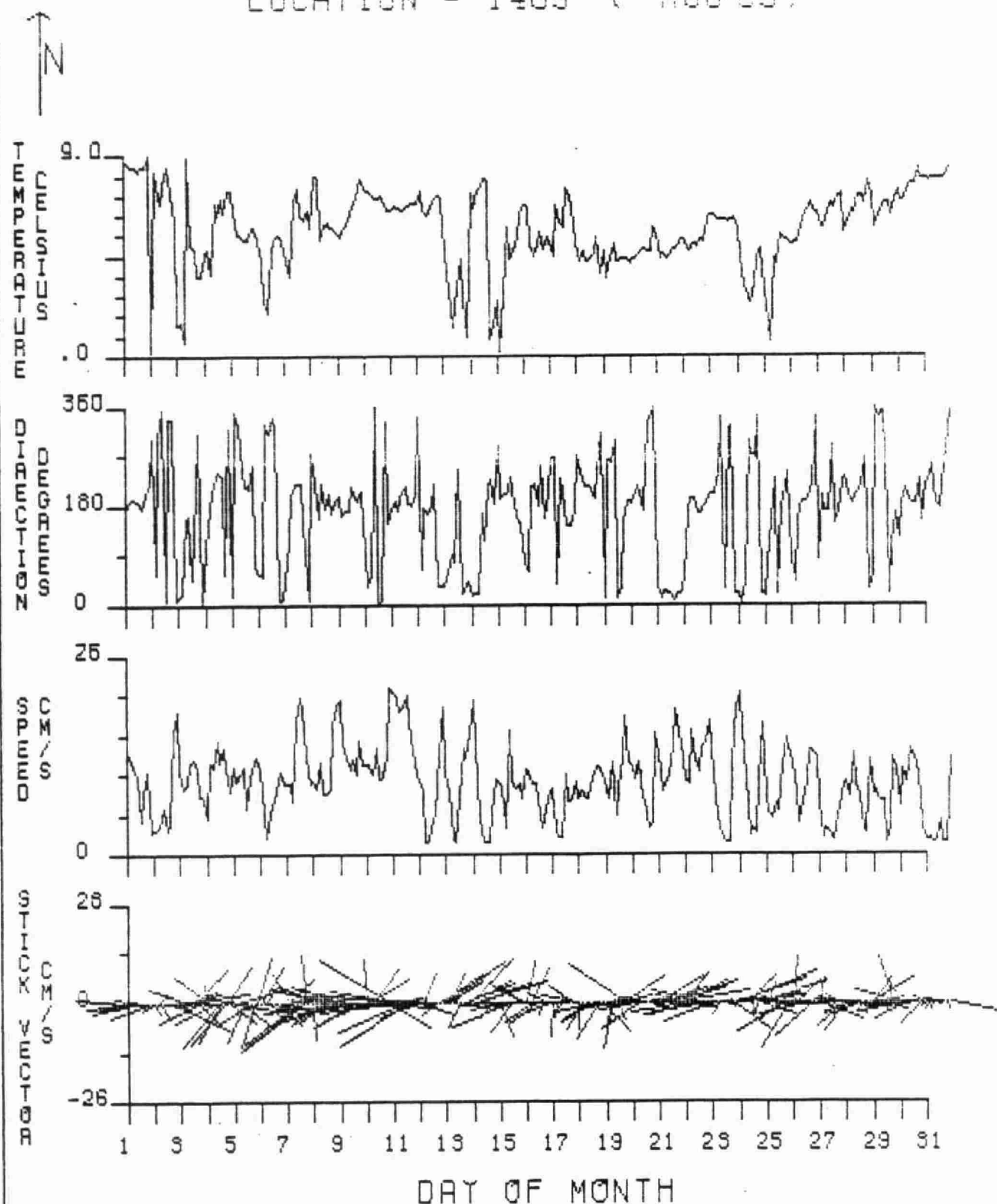


FIG. 1.14: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1409 (SEP 83)

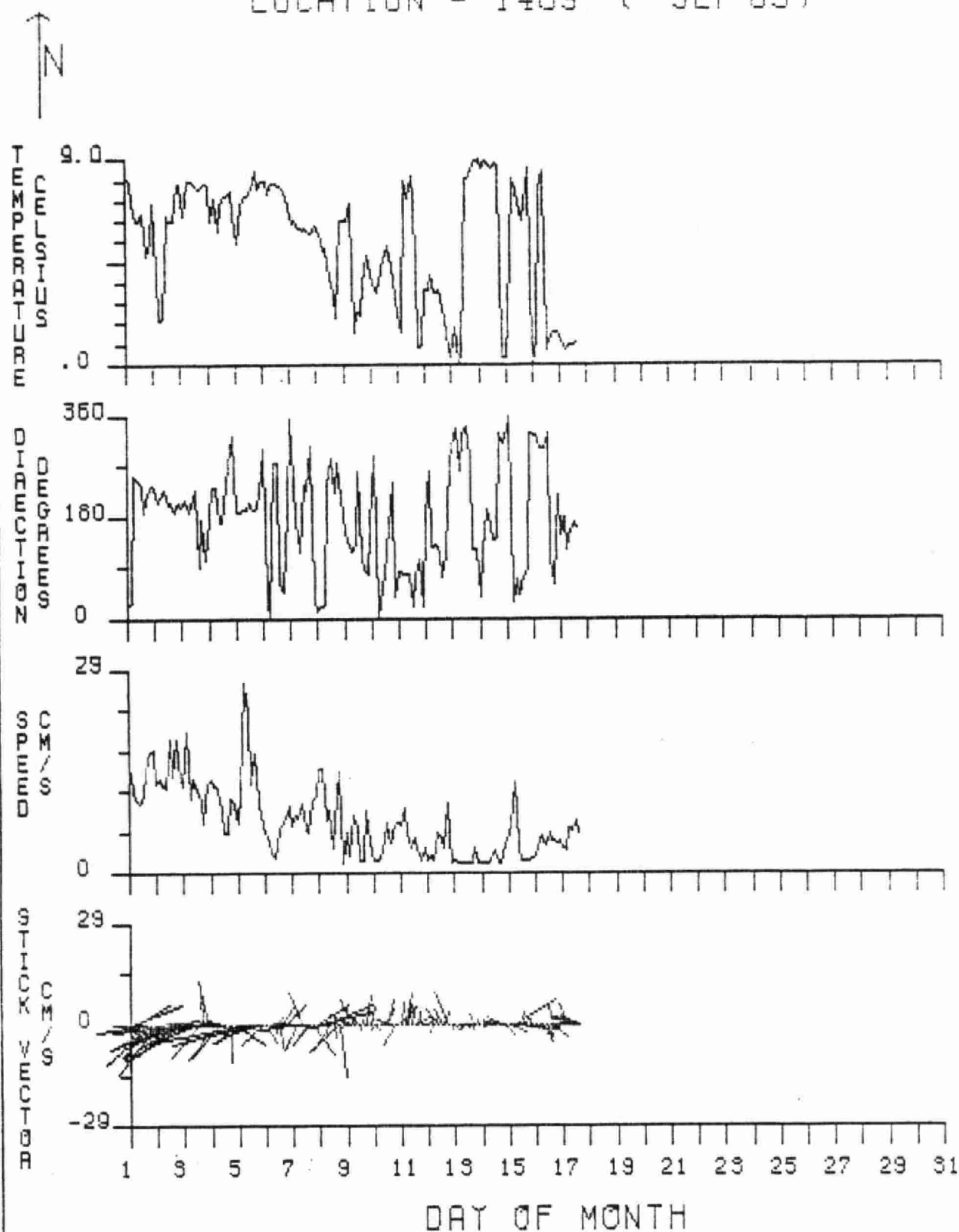


FIG.1.15: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1410 (MAY 83)

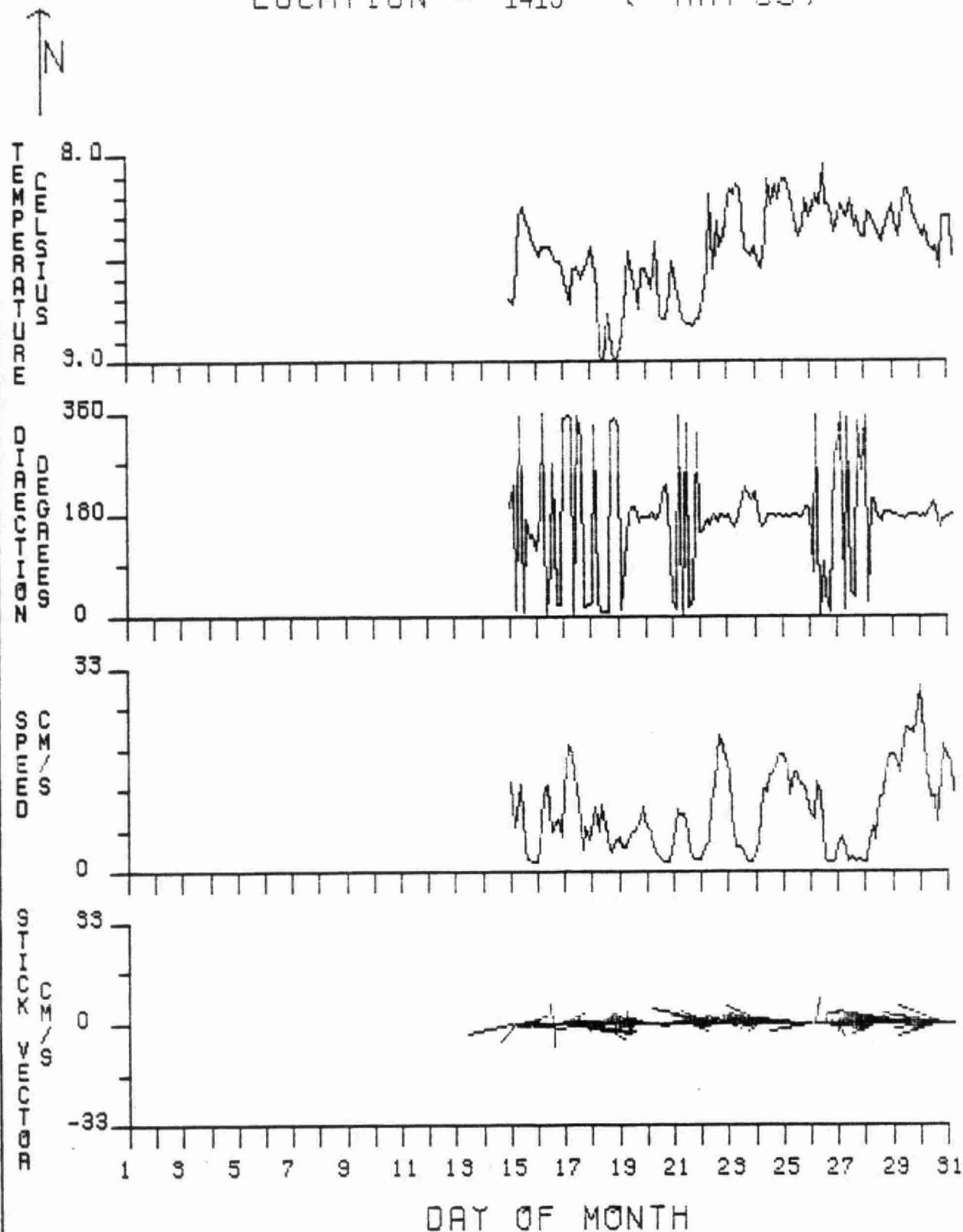


FIG.1.16: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1410 (JUN 83)

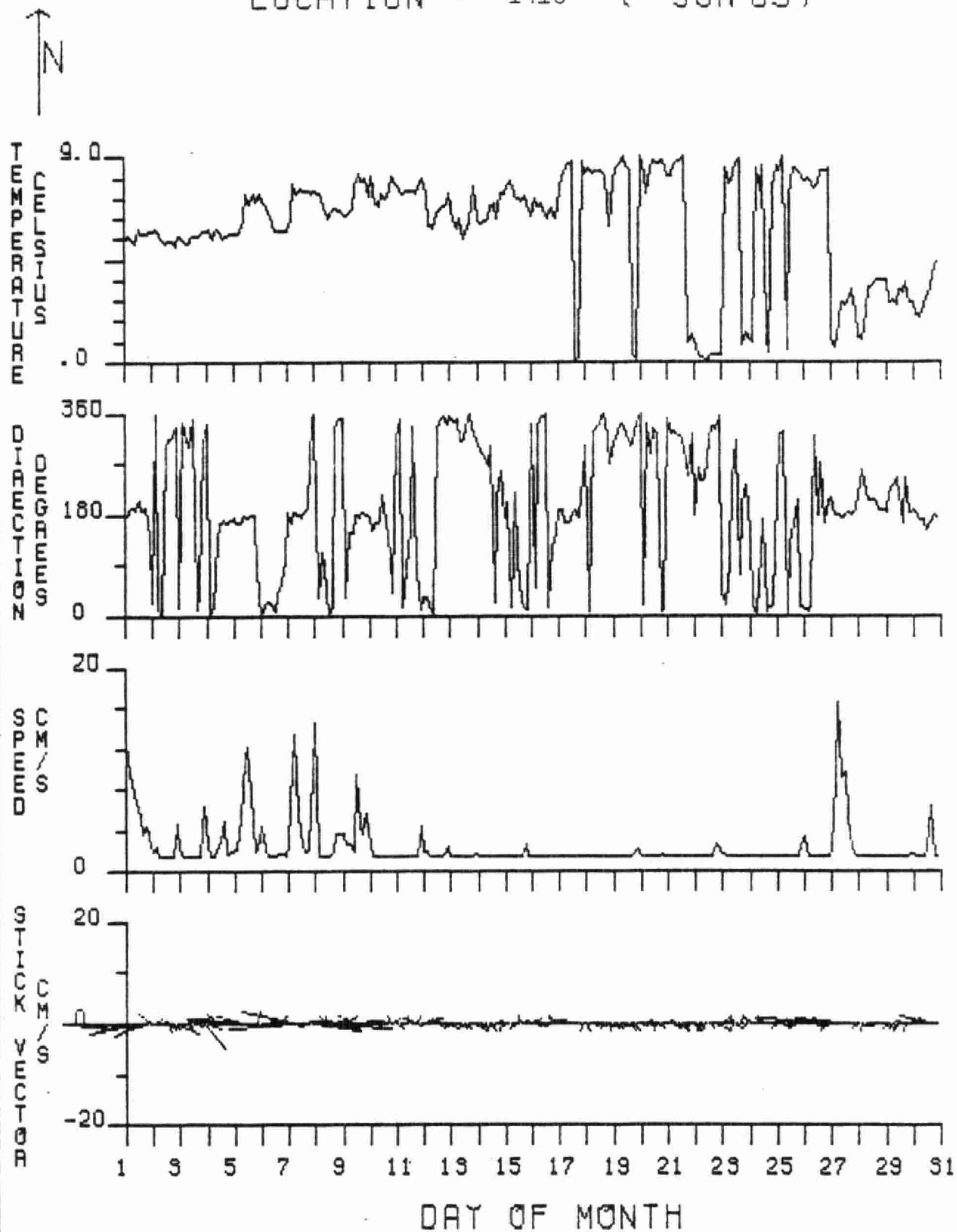


FIG.1.17 : VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1410 (JUL 83)

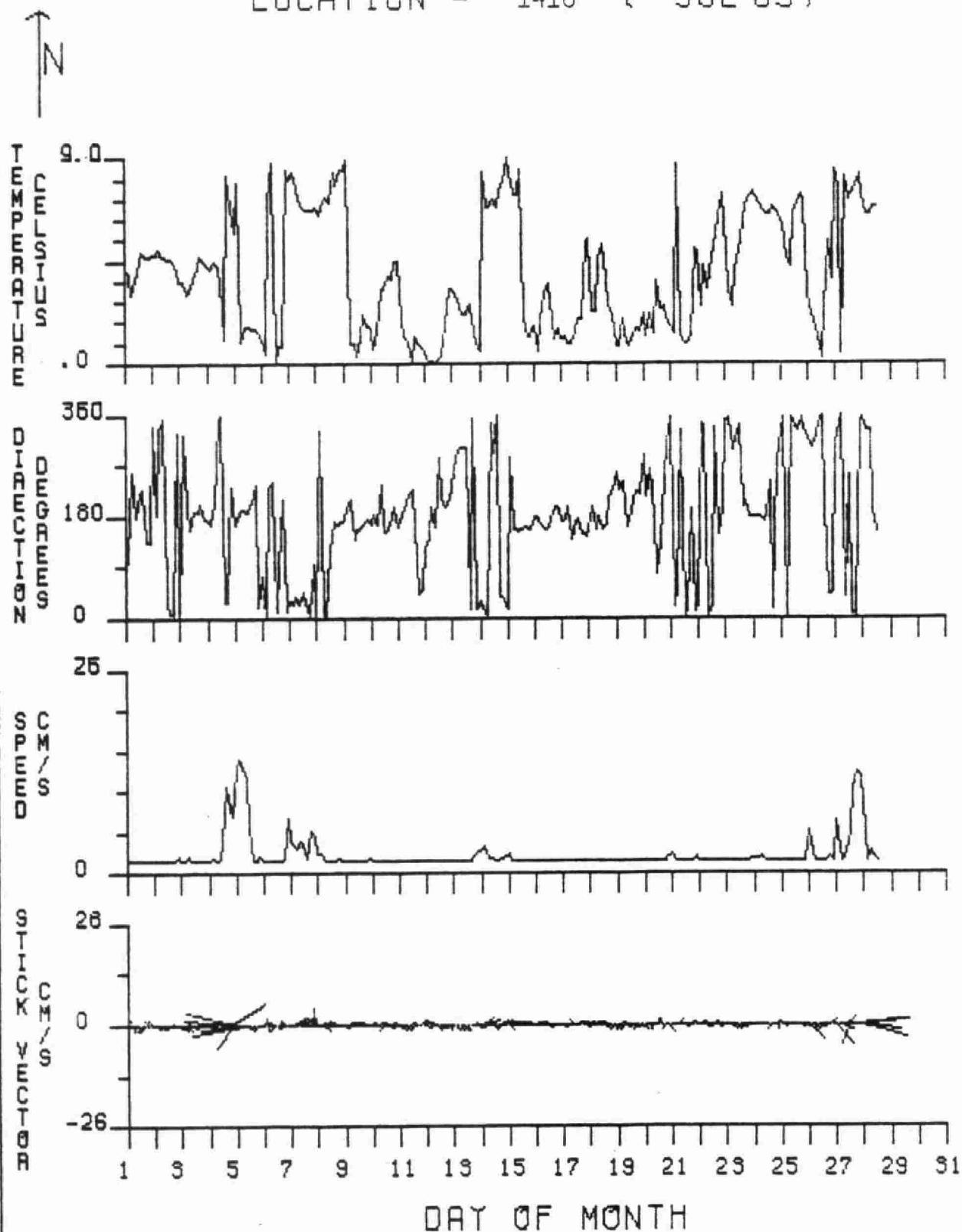


FIG.1.18: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1410 (AUG 83)

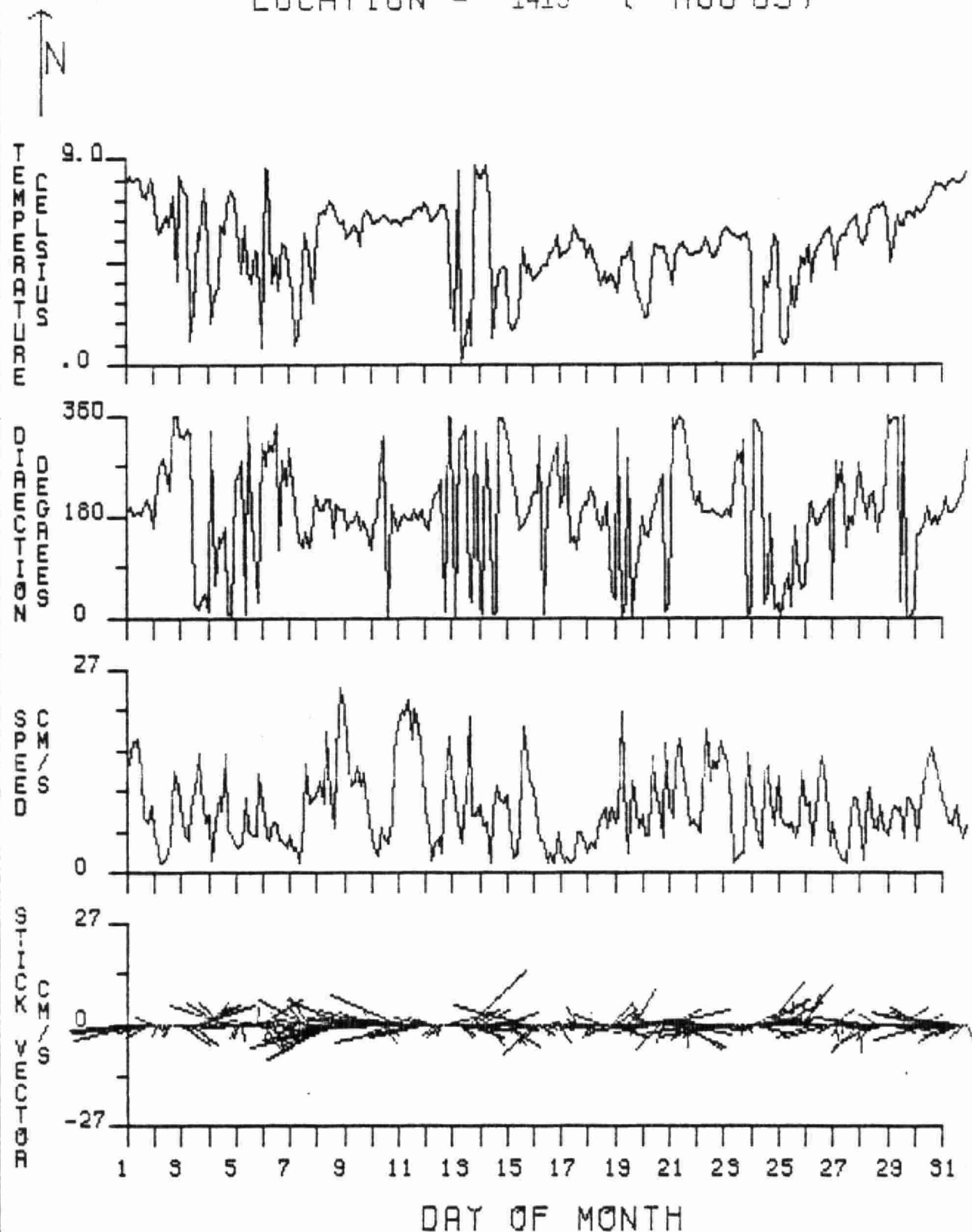


FIG.1.19: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 141C (SEP 83)

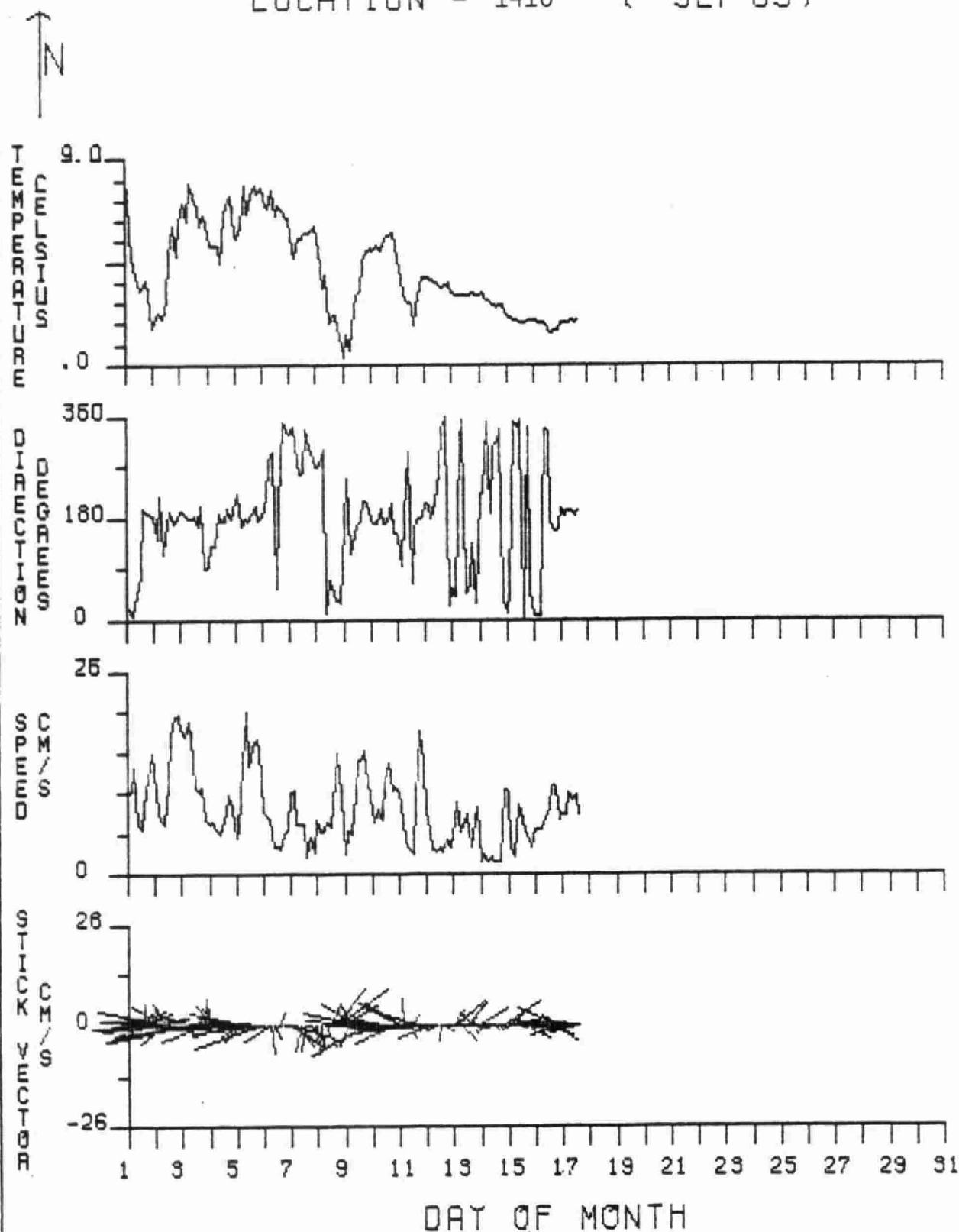
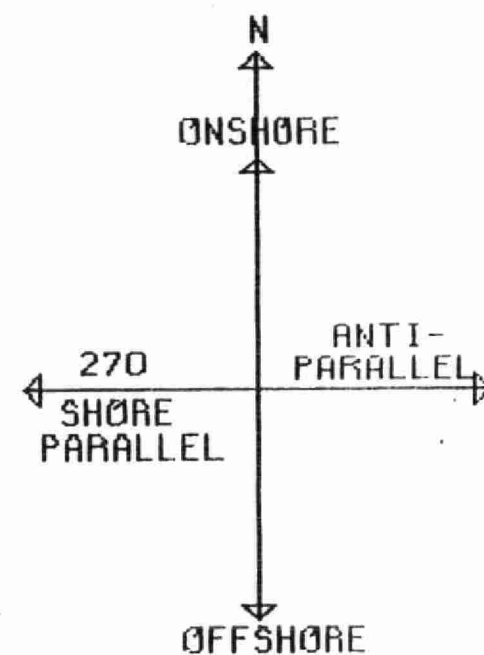
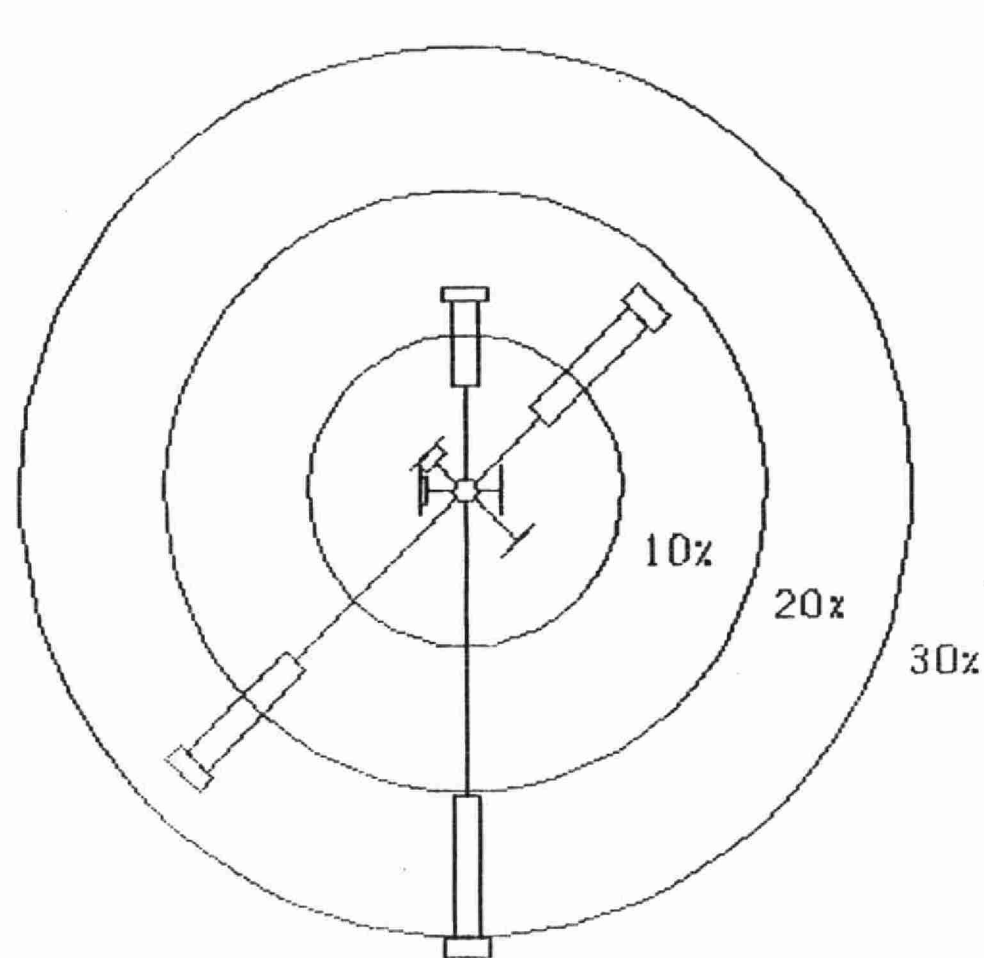


FIG.1.20: VARIATION OF CURRENT DIRECTION, SPEED AND TEMPERATURE WITH TIME : THUNDER BAY L. SUPERIOR

LOCATION - 1407 (MAY 83)

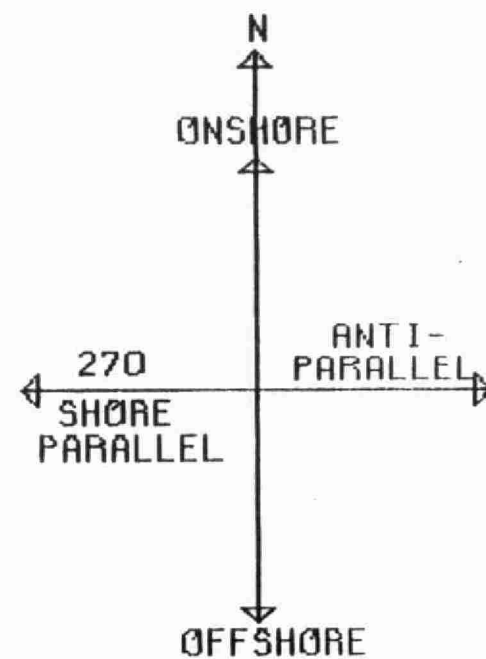
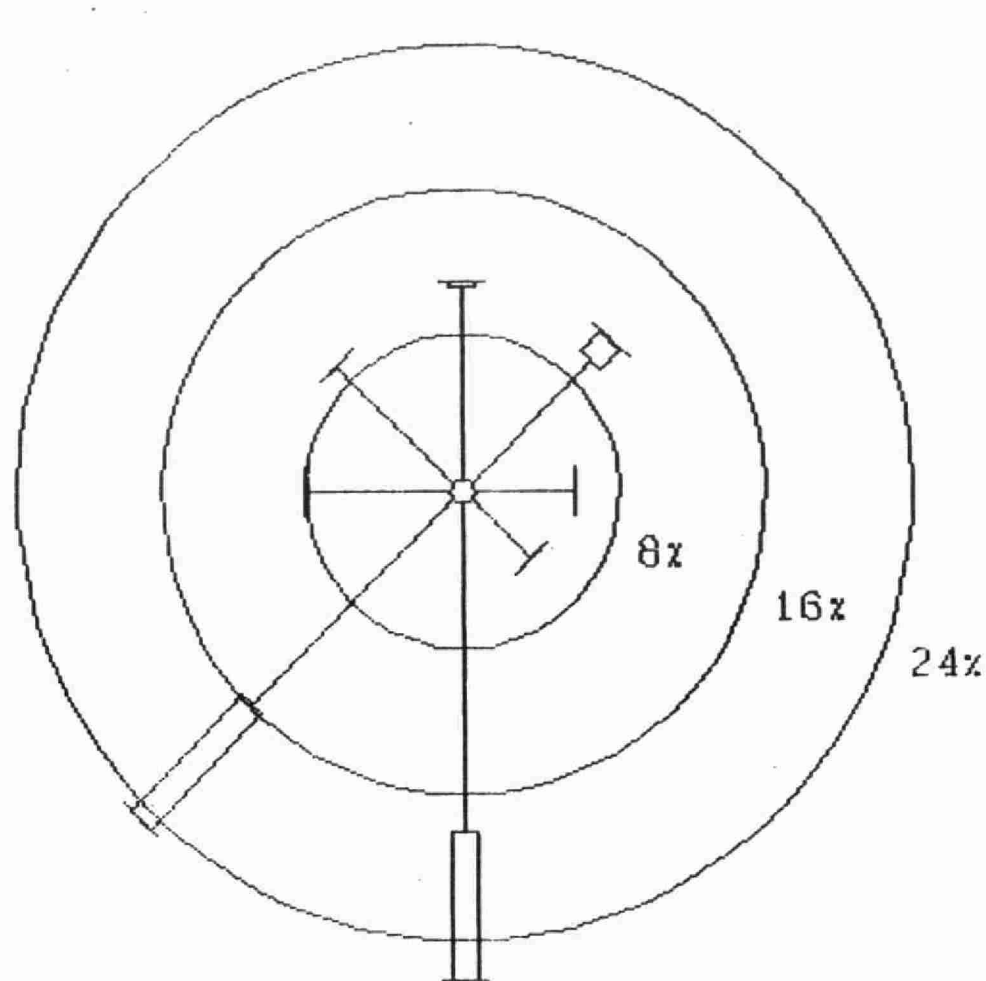


LEGEND

- 1.5 - 5.0 CM/S
- 5.0 - 13.0 CM/S
- 13.0 + CM/S

FIG.2.01 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1407 (JUN 83)



LEGEND

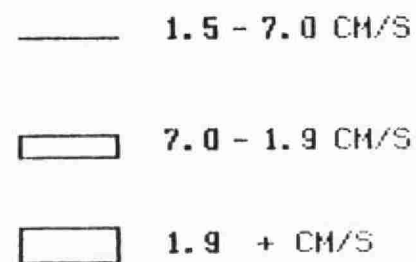
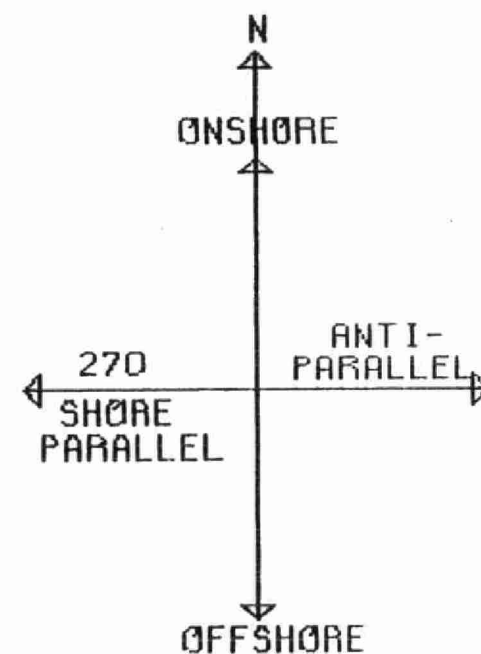
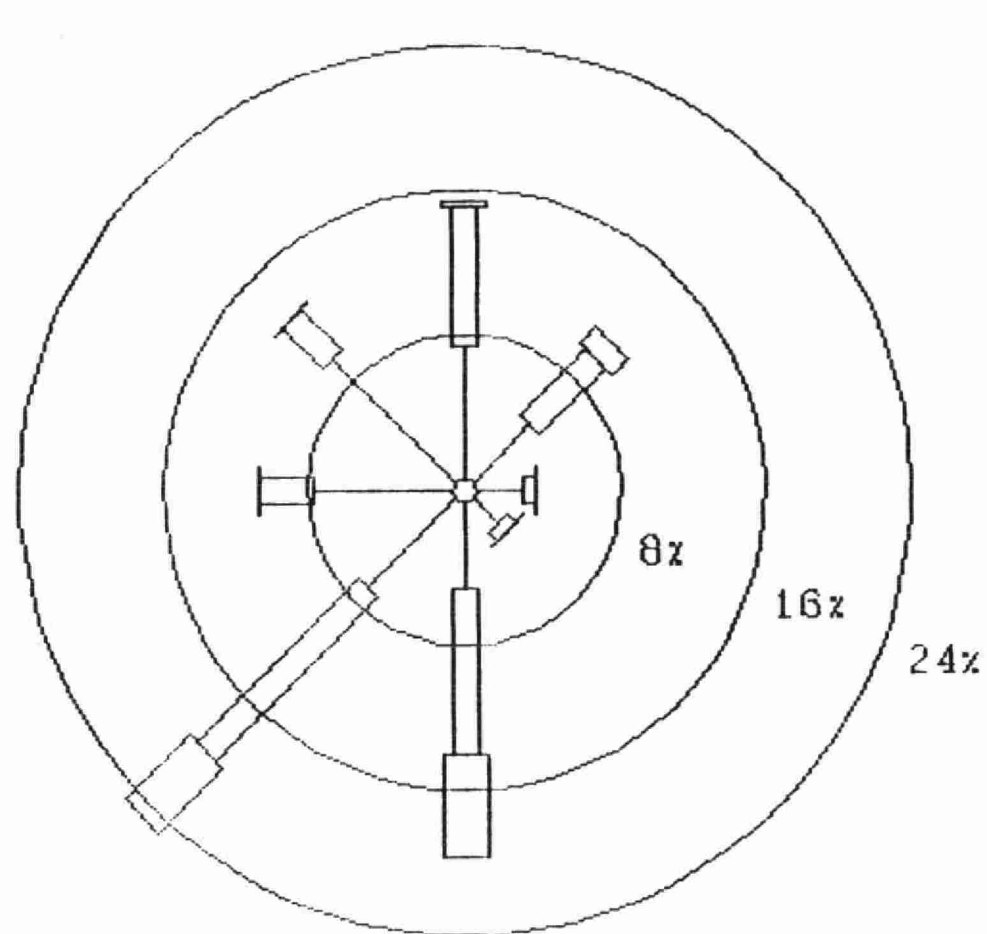


FIG. 2.02 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1407 (JUL 83)



LEGEND

- 1.5 - 4.0 CM/S
- 4.0 - 10.0 CM/S
- 10.0 + CM/S

FIG. 2.03 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1407 (AUG 83)

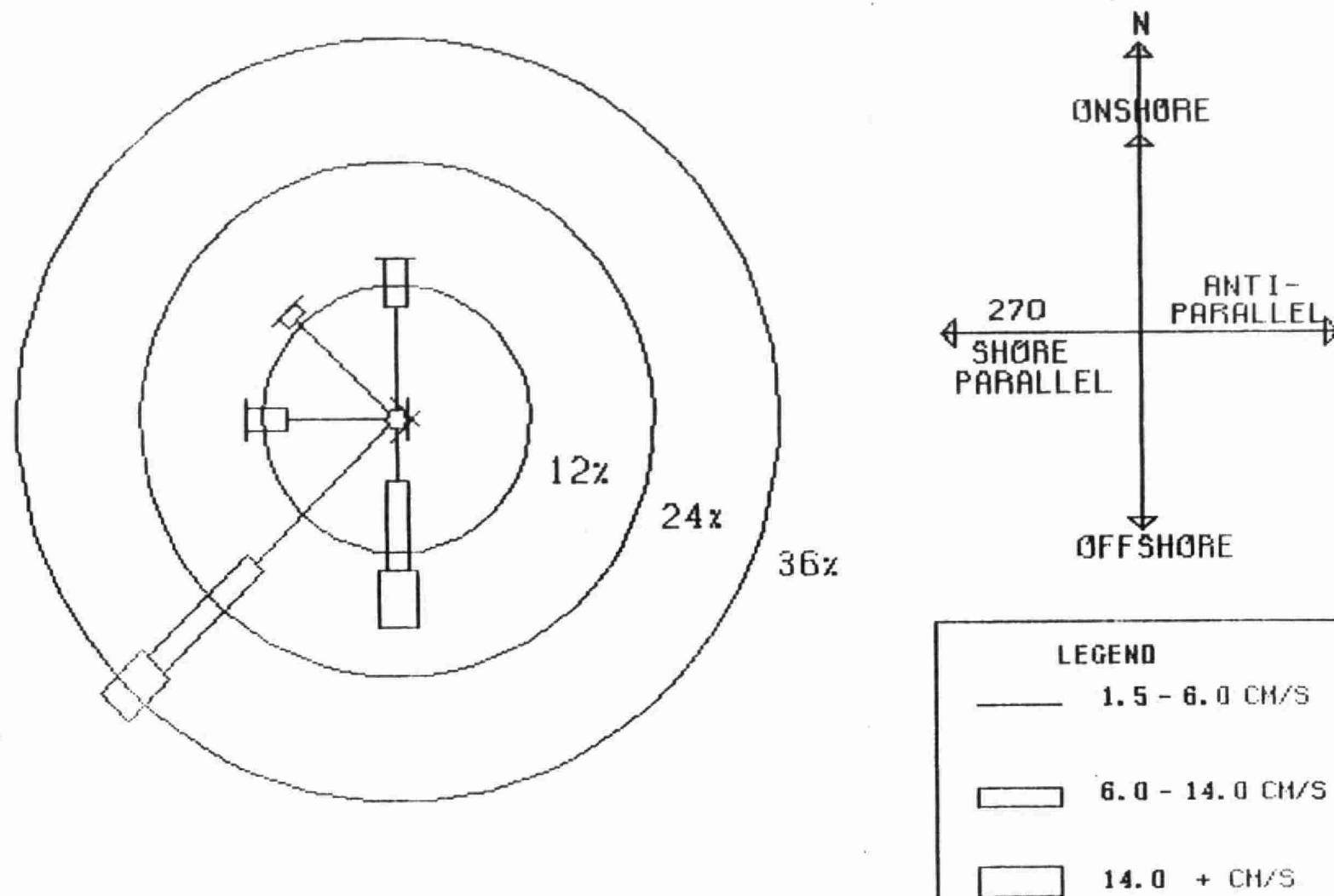


FIG. 2.04 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1407 (SEP 83)

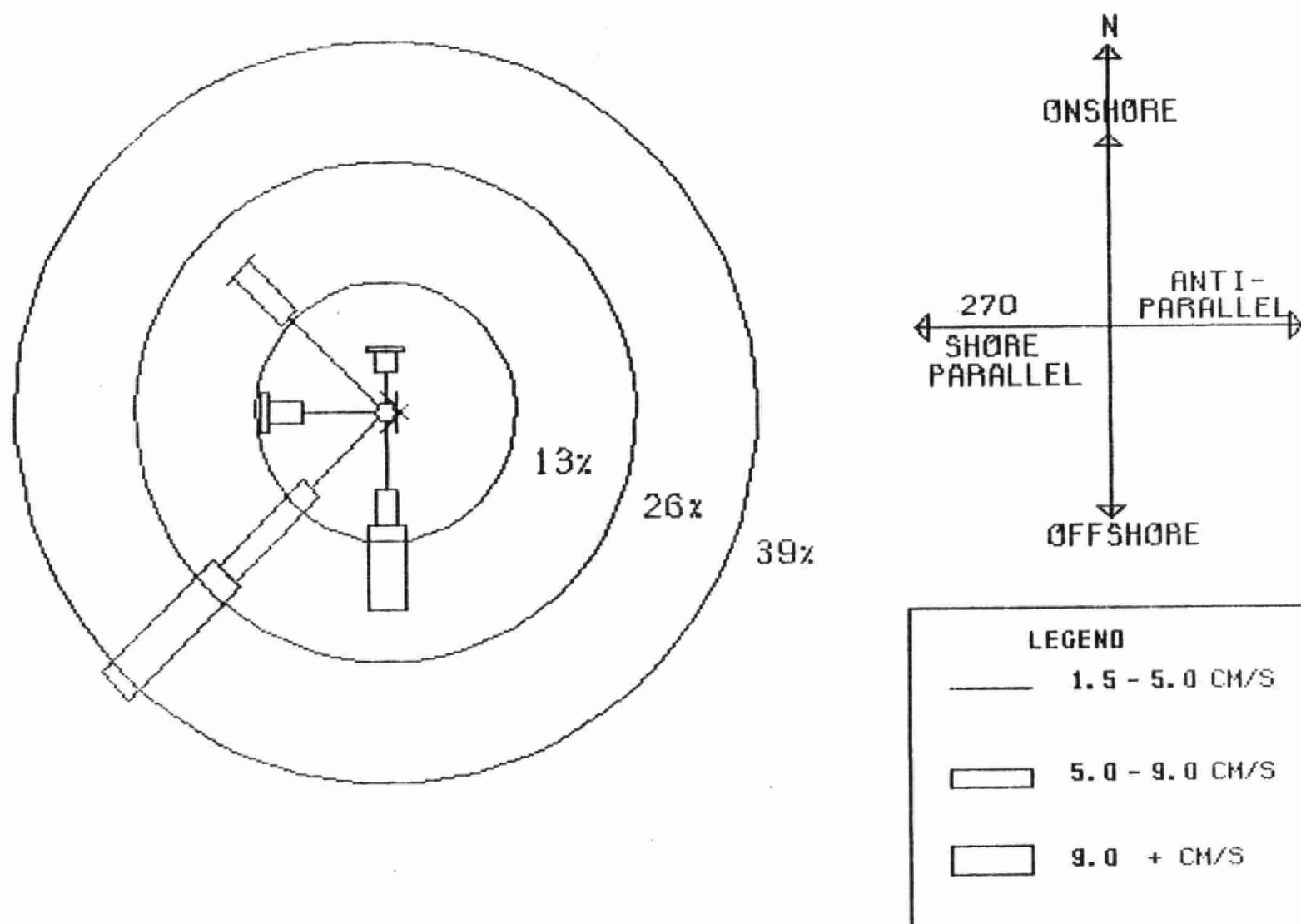


FIG. 2.05 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1408 (MAY 83)

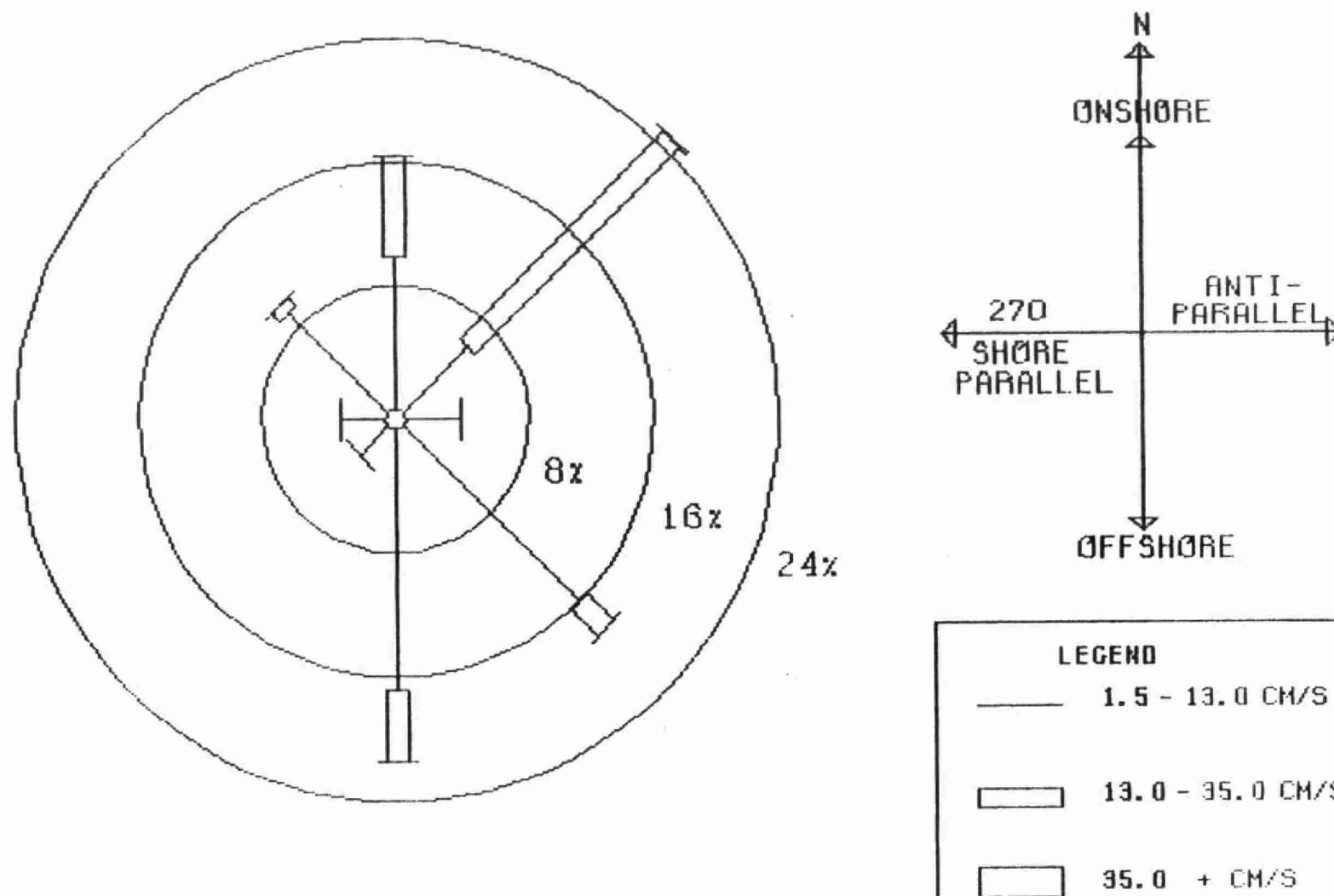
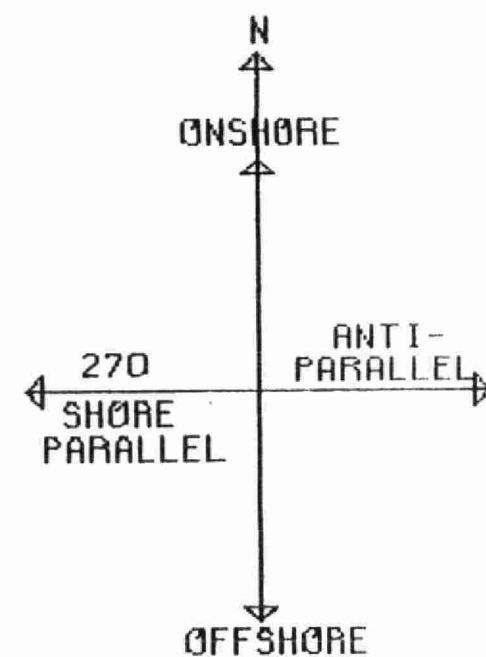
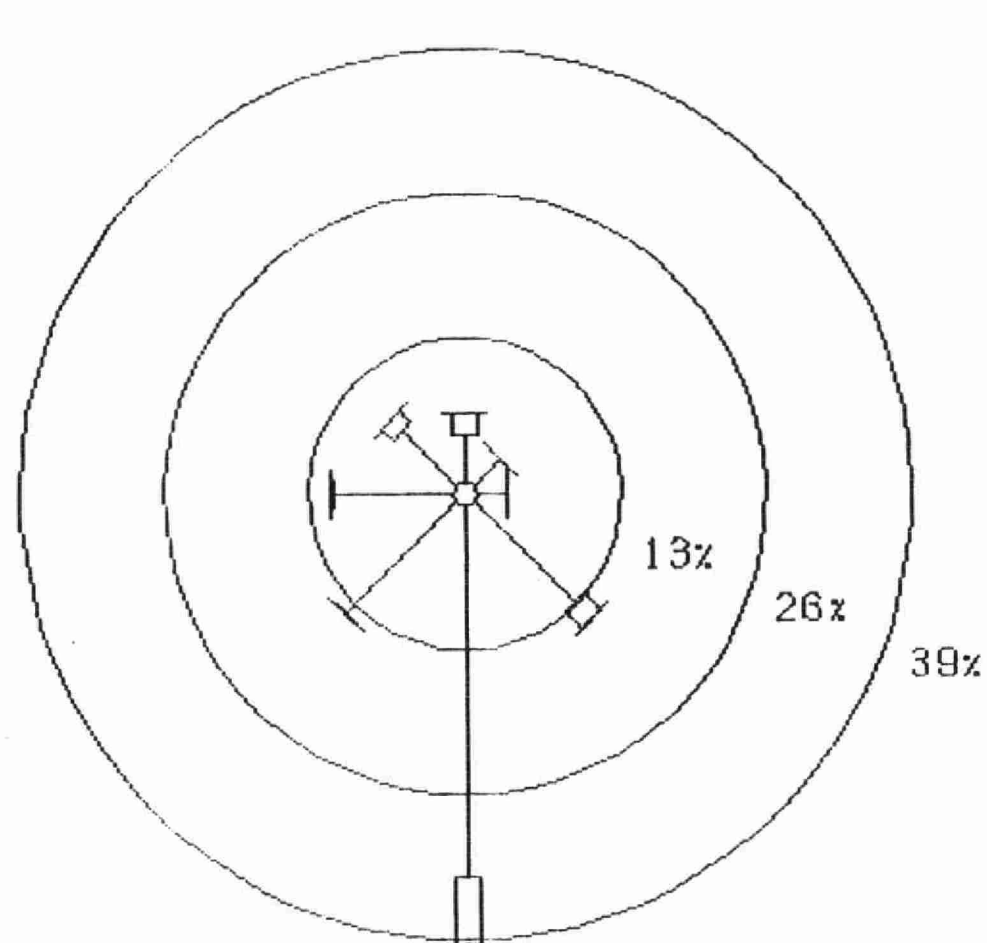


FIG. 2.06 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1408 (JUN 83)



LEGEND

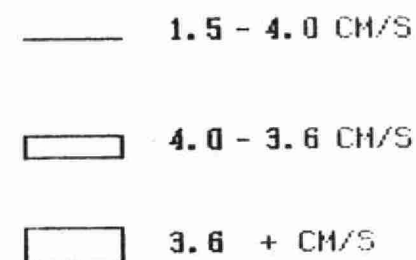


FIG. 2.07 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1408 (JUL 83)

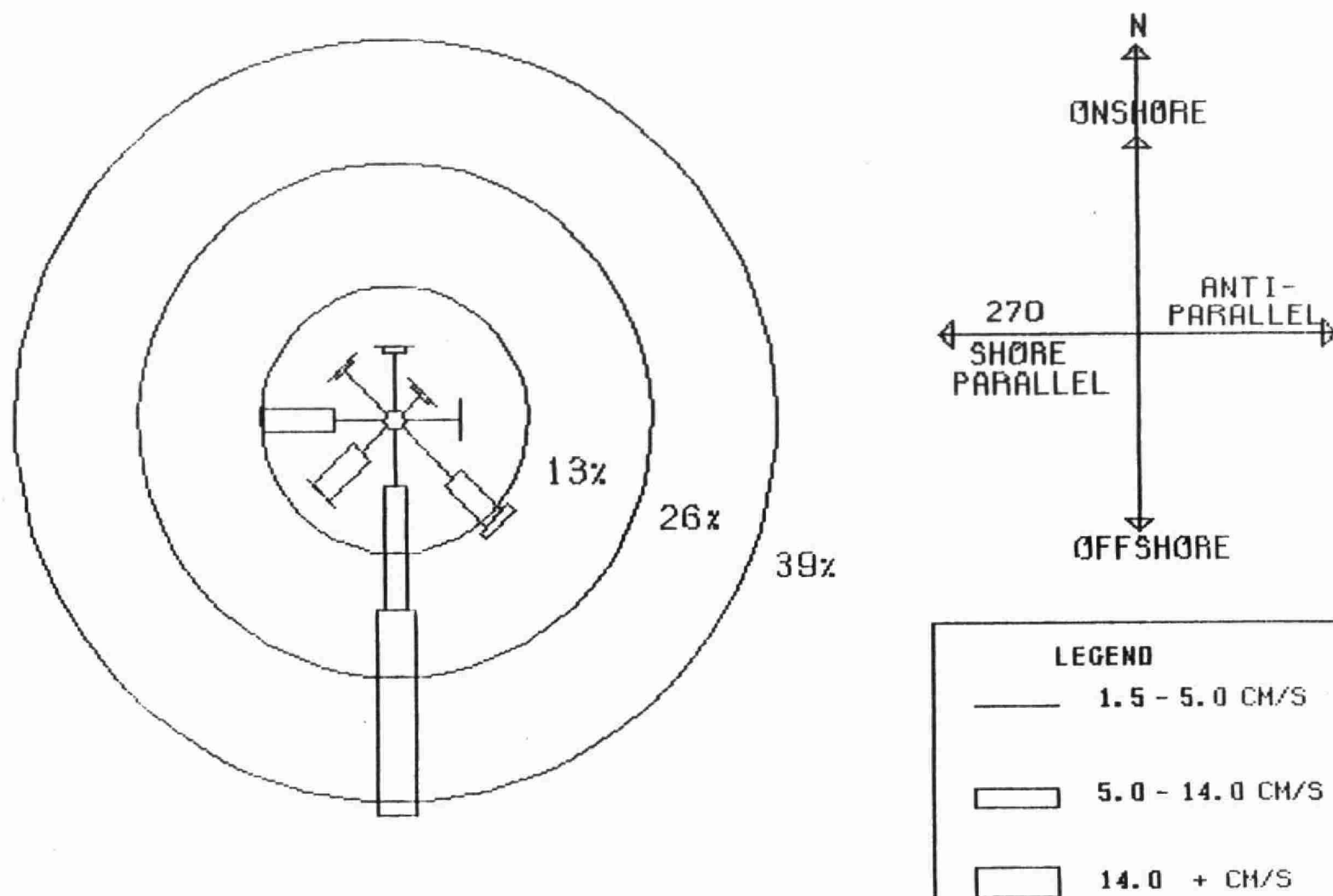


FIG. 2.08 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1408 (AUG 83)

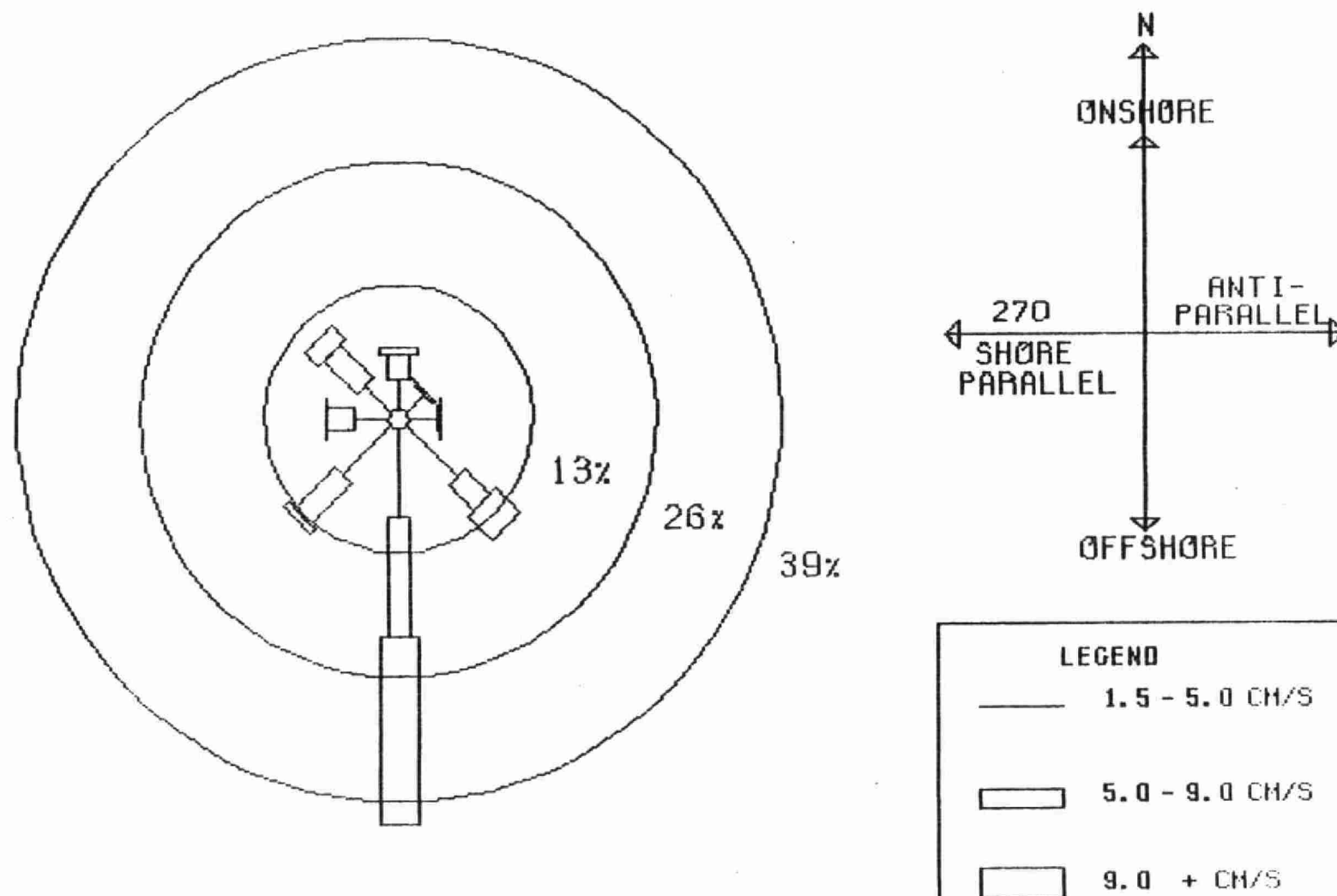


FIG.2.09 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1408 (SEP 83)

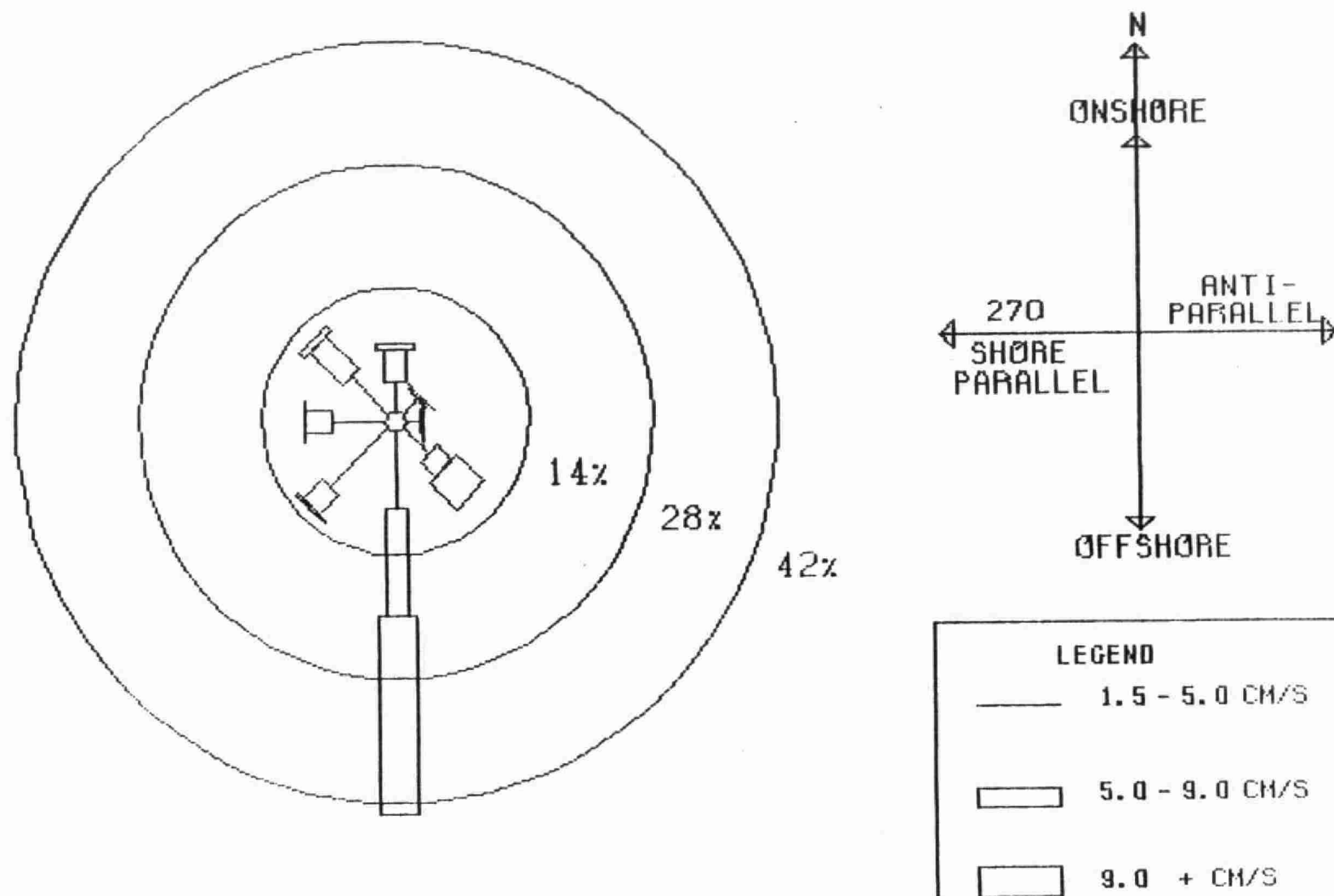


FIG. 2.10 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1409 (MAY 83)

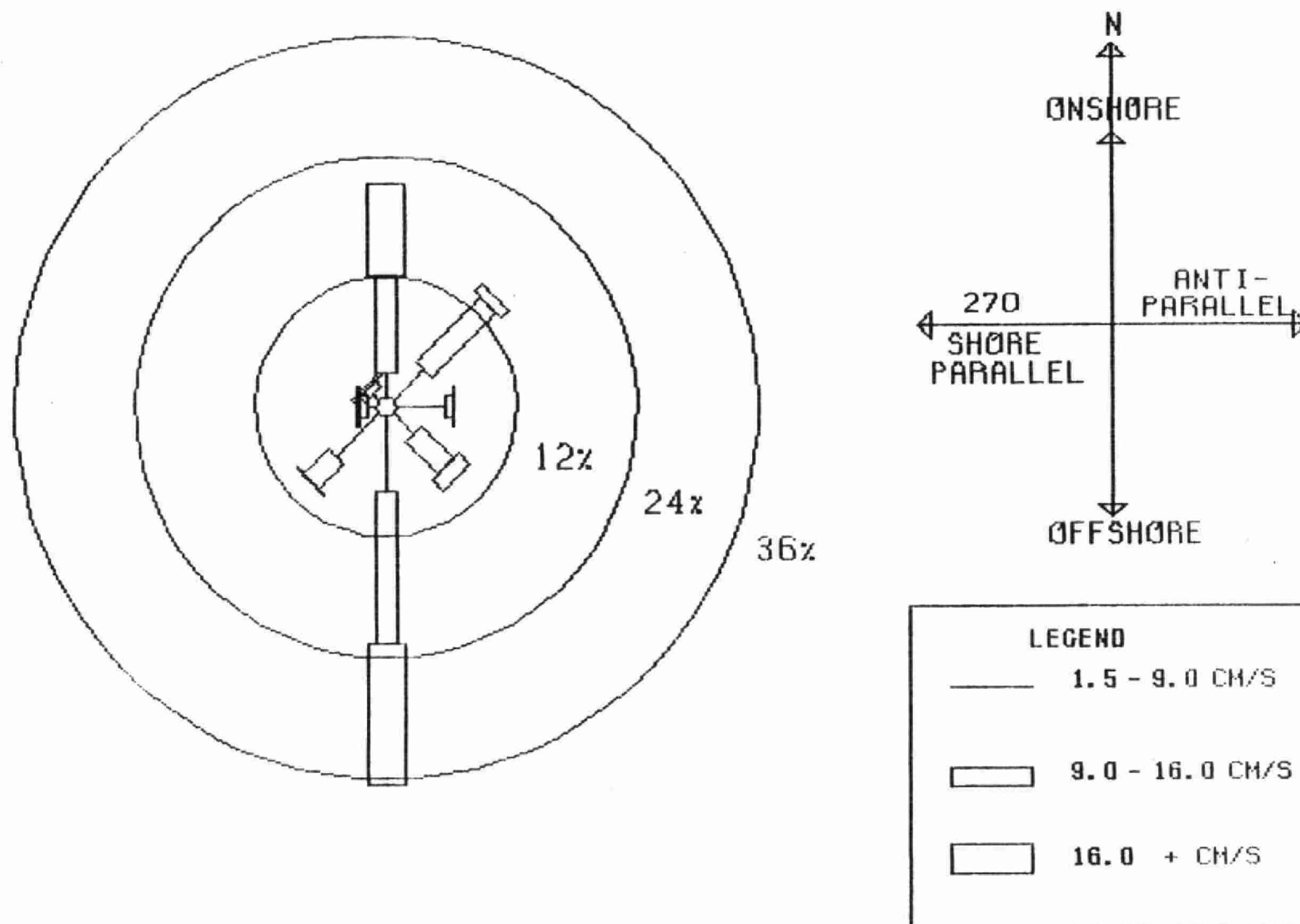
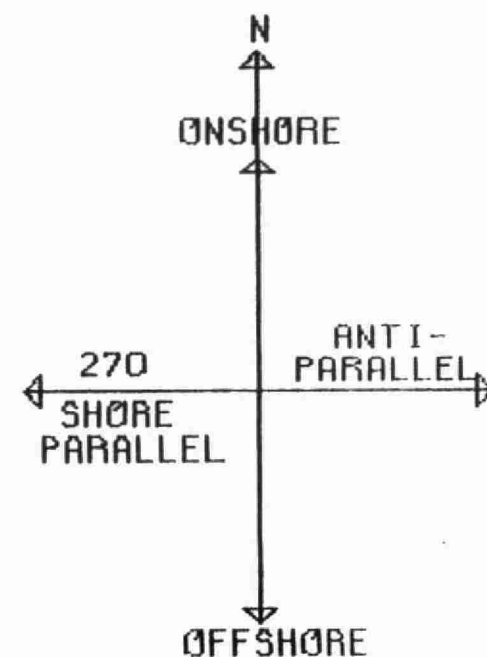
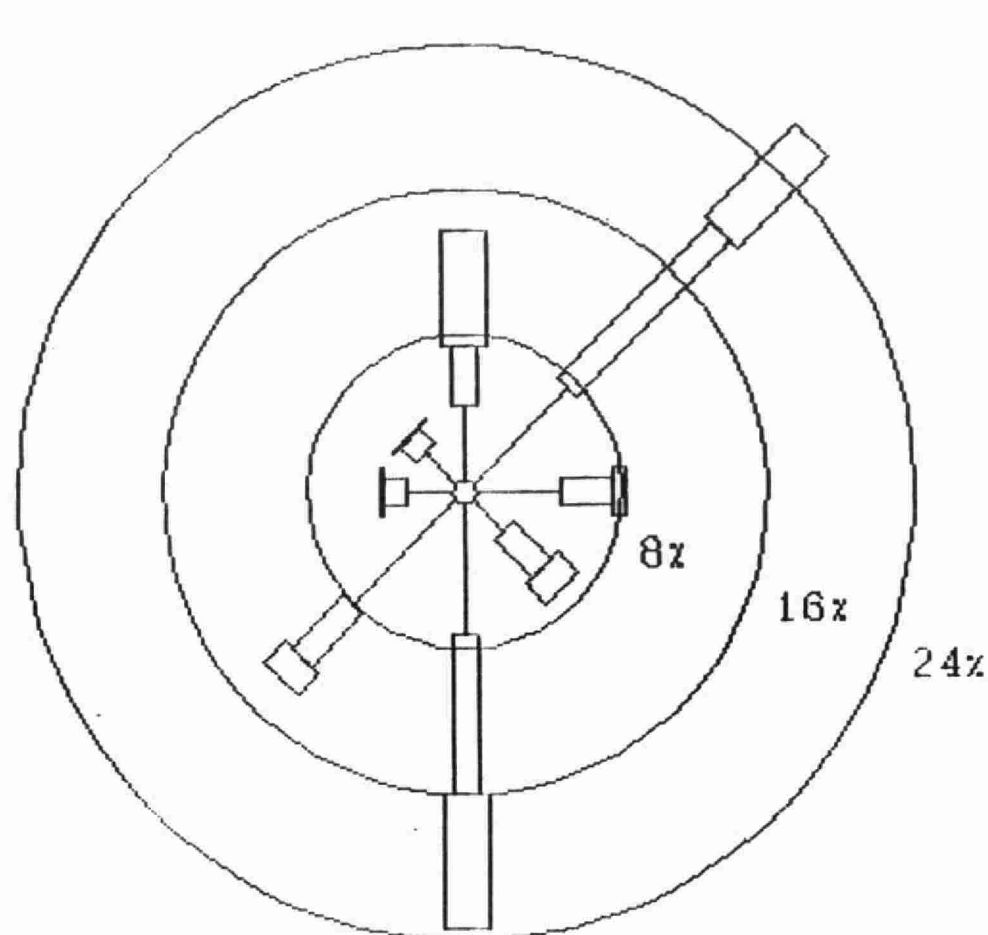


FIG. 2.11 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1409 (JUN 83)

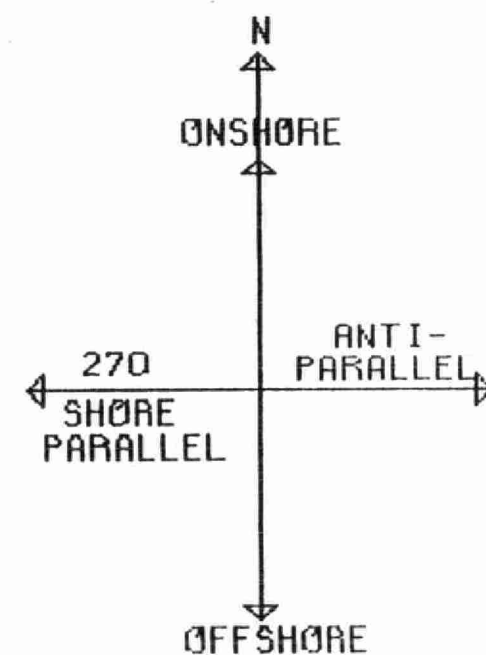
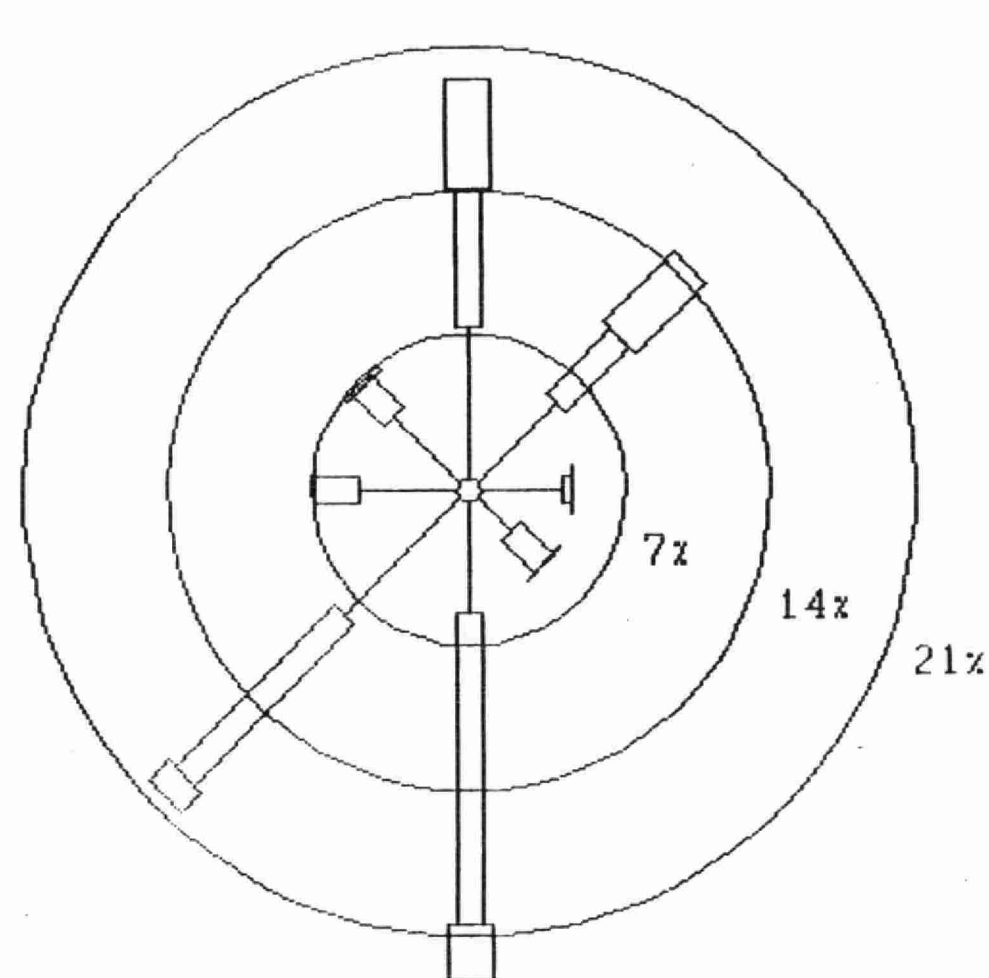


LEGEND

- 1.5 - 9.0 CM/S
- ▭ 9.0 - 13.0 CM/S
- ▭ 13.0 + CM/S

FIG. 2.12 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1409 (JUL 83)



LEGEND

- 1.5 - 8.0 CM/S
- ▭ 8.0 - 14.0 CM/S
- ▭ 14.0 + CM/S

FIG. 2.13 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1409 (AUG 83)

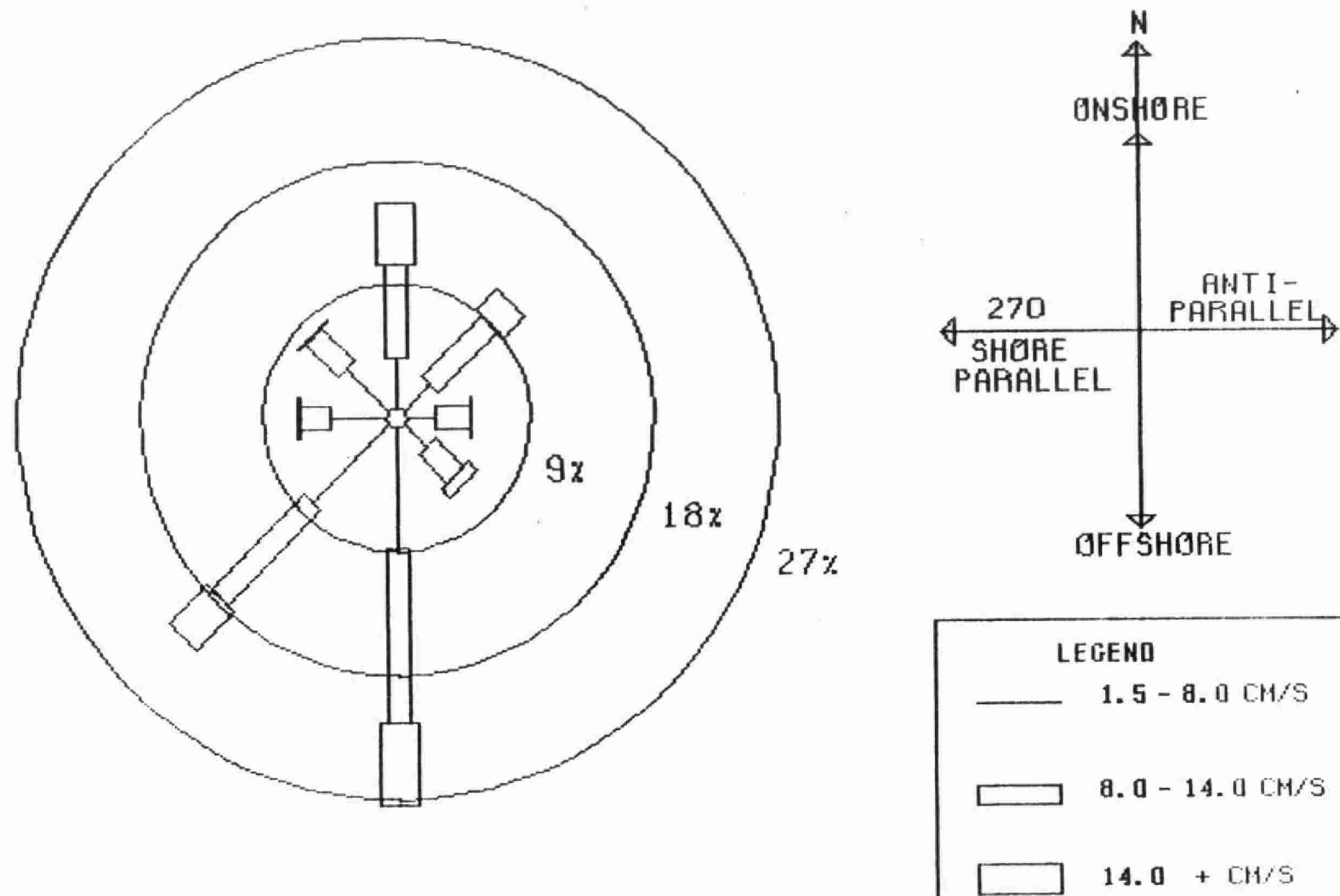


FIG.2.14 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1409 (SEP 83)

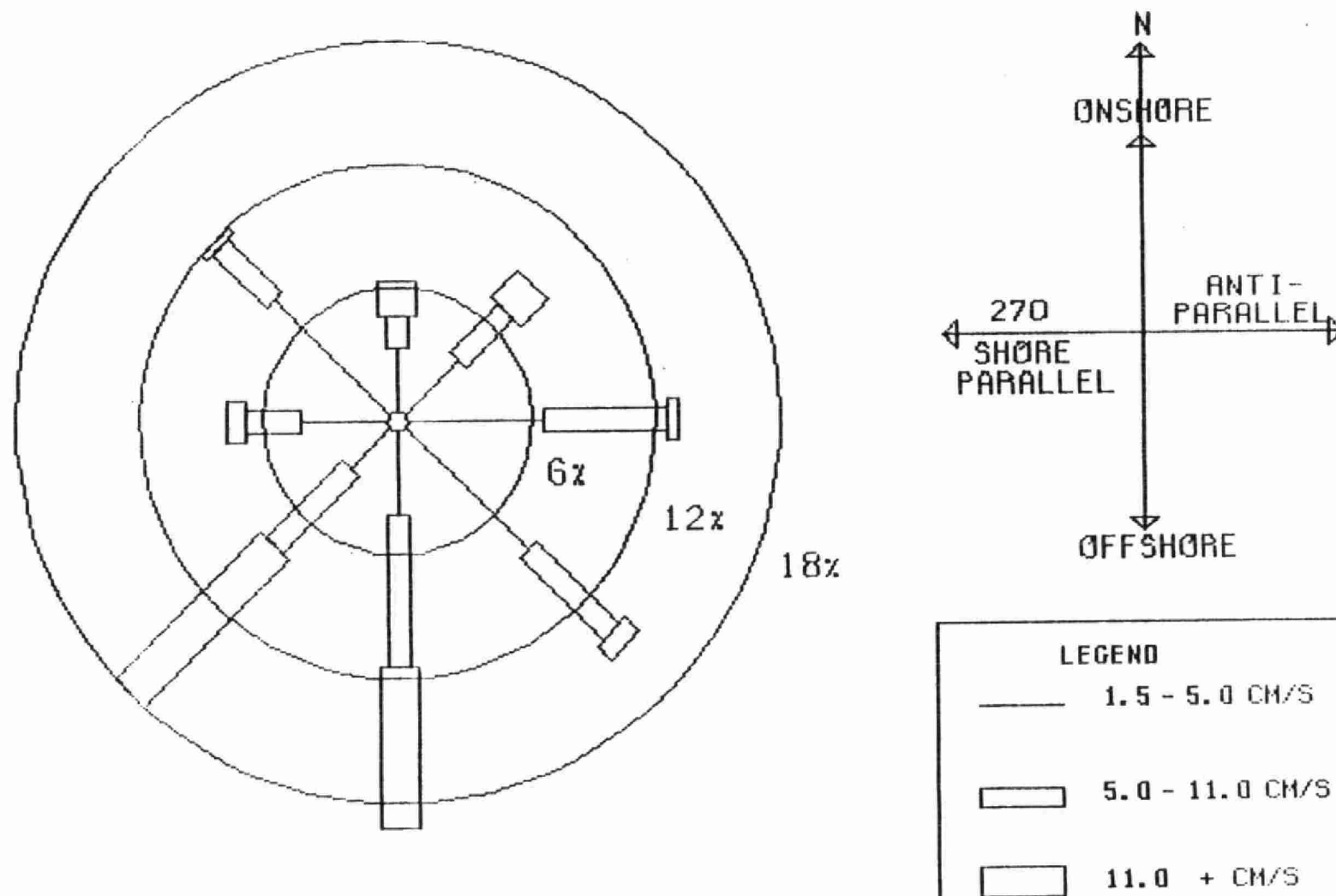


FIG.2.15 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1410 (MAY 83)

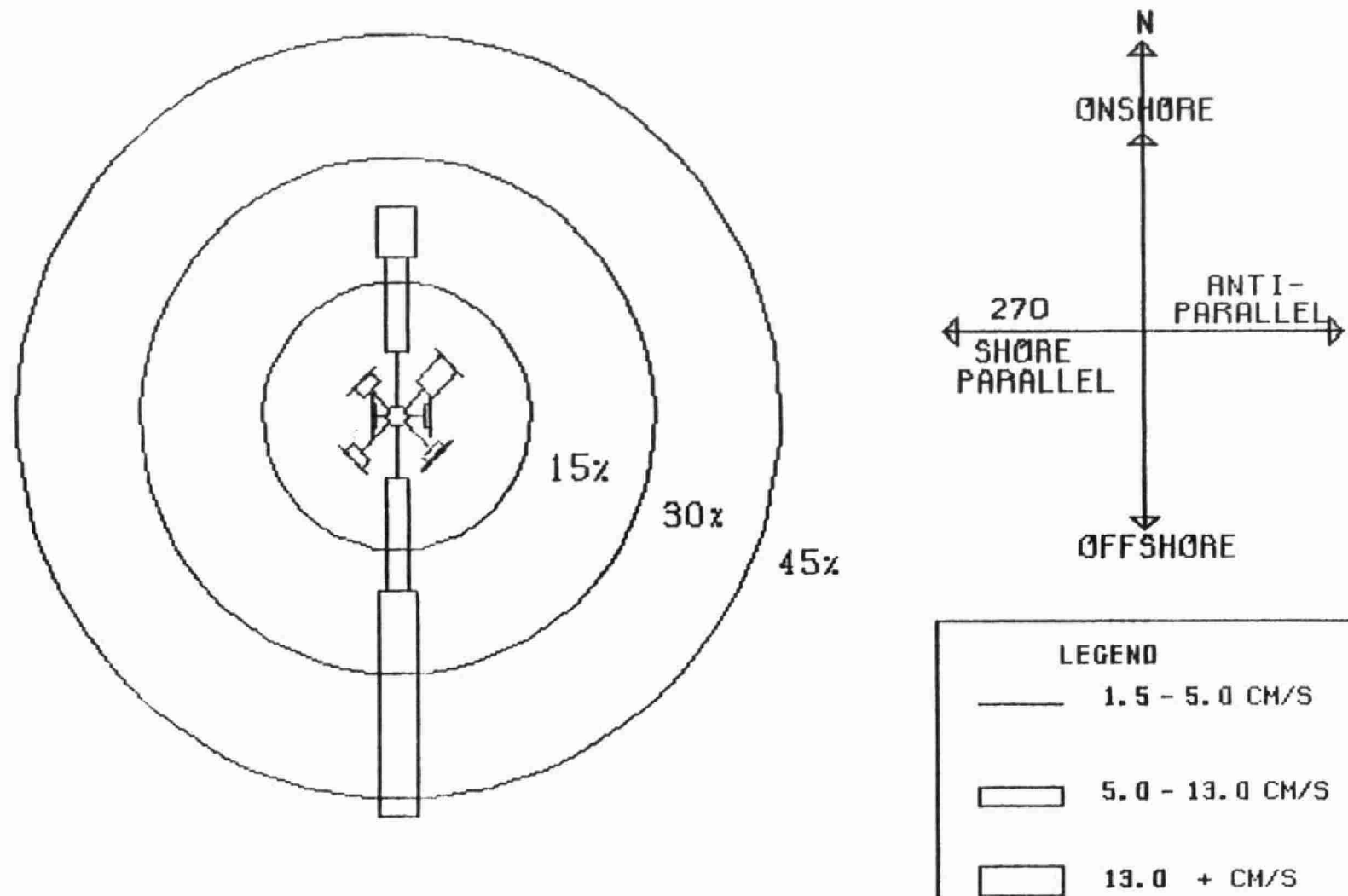
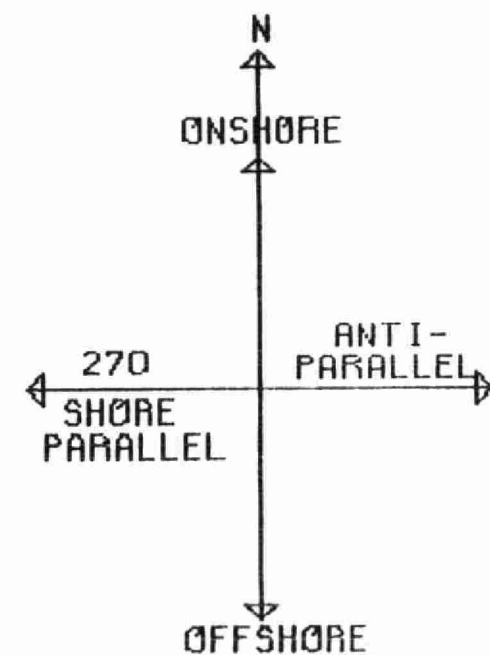
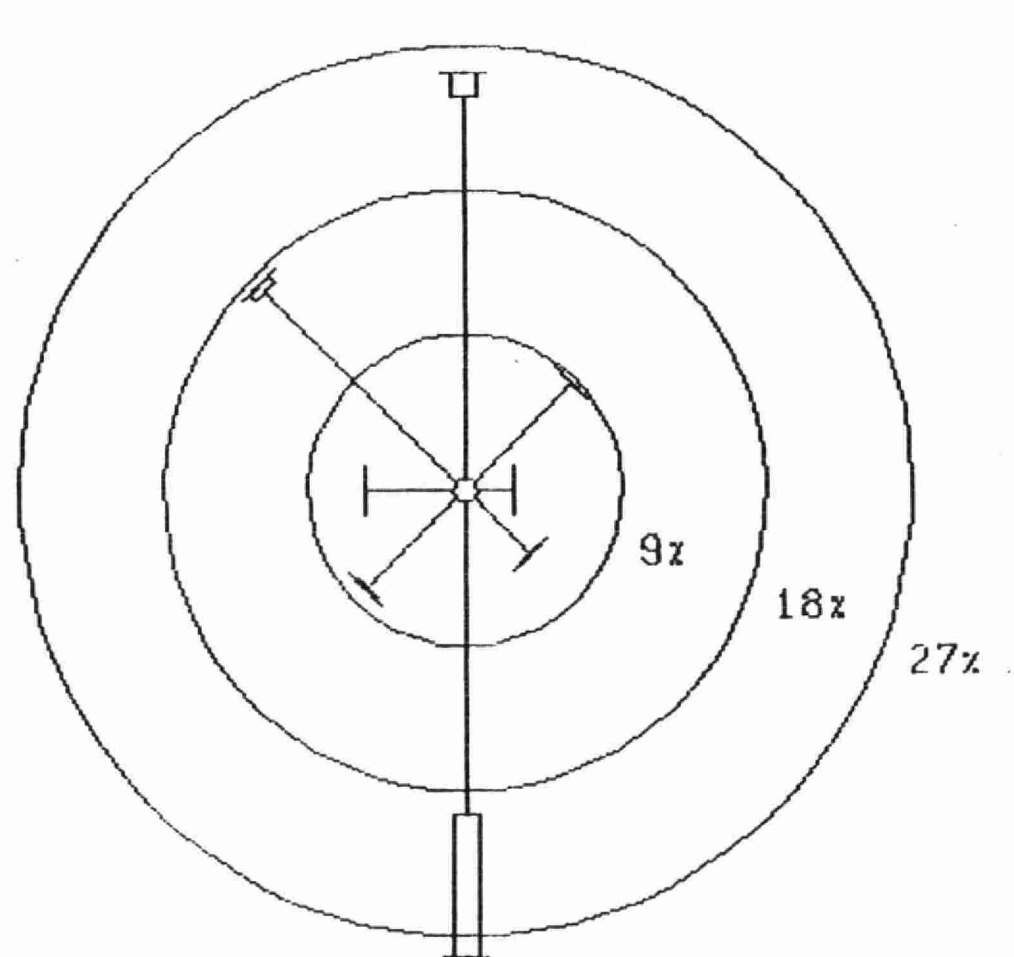


FIG. 2.16: CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1410 (JUN 83)



LEGEND

- 1.5 - 4.0 CM/S
- 4.0 - 2.8 CM/S
- 2.8 + CM/S

FIG. 2.17 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1410 (JUL 83)

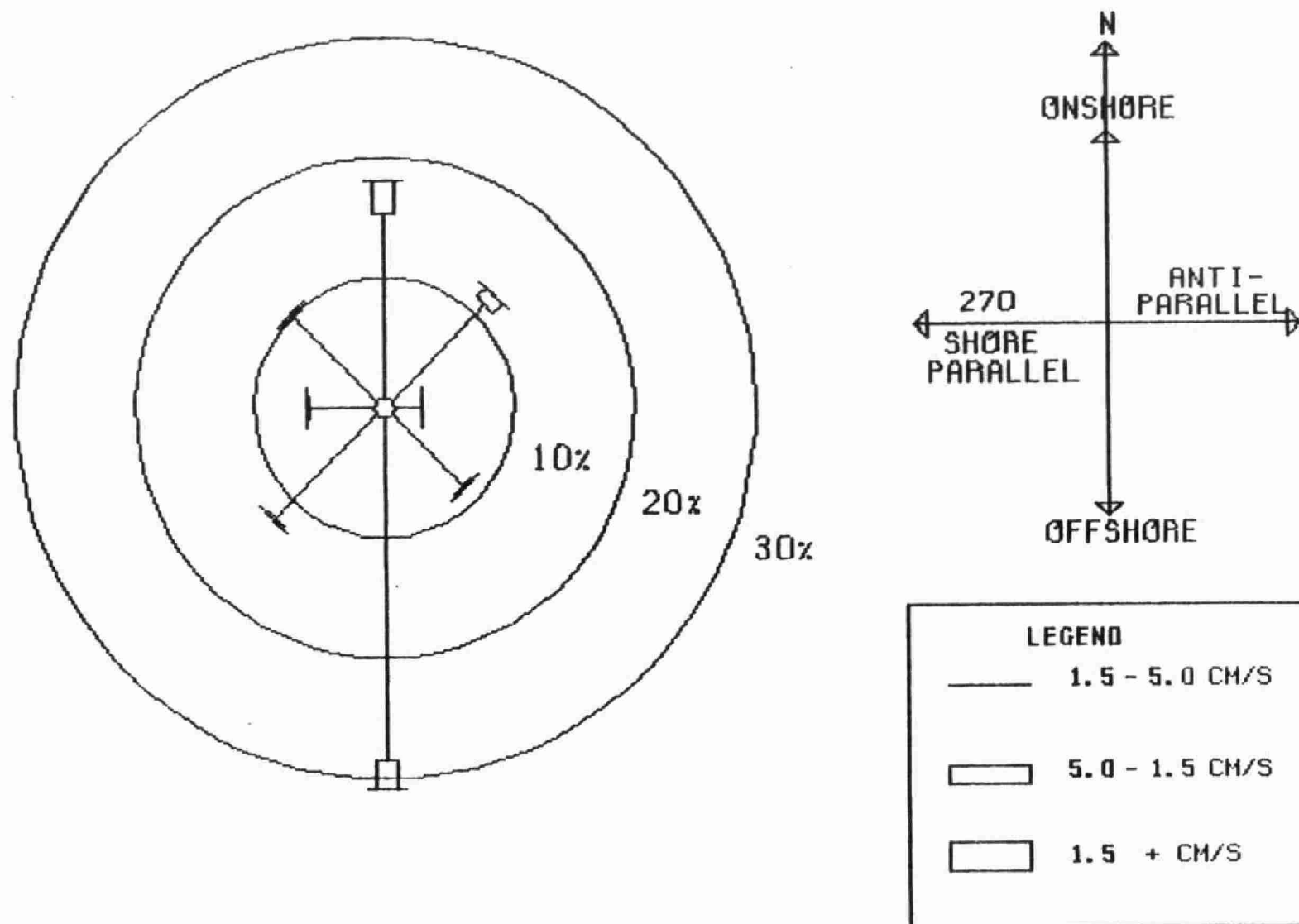


FIG. 2.18 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1410 (AUG 83)

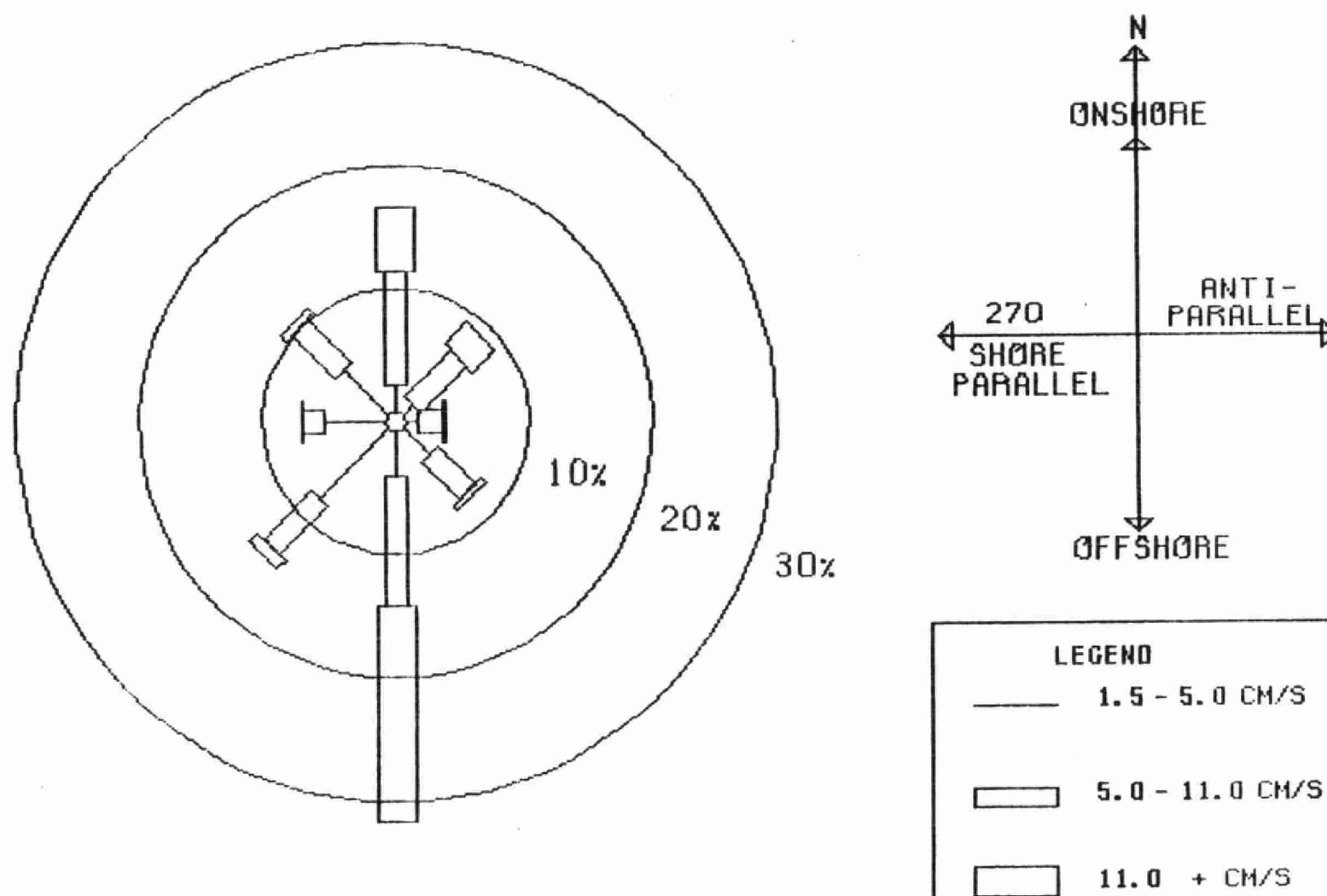
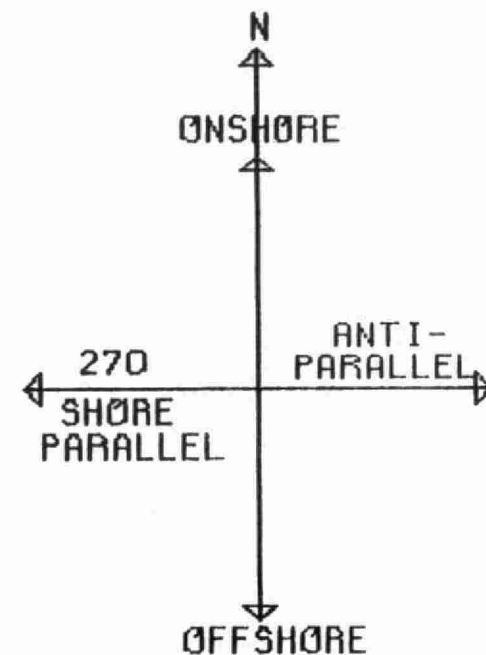
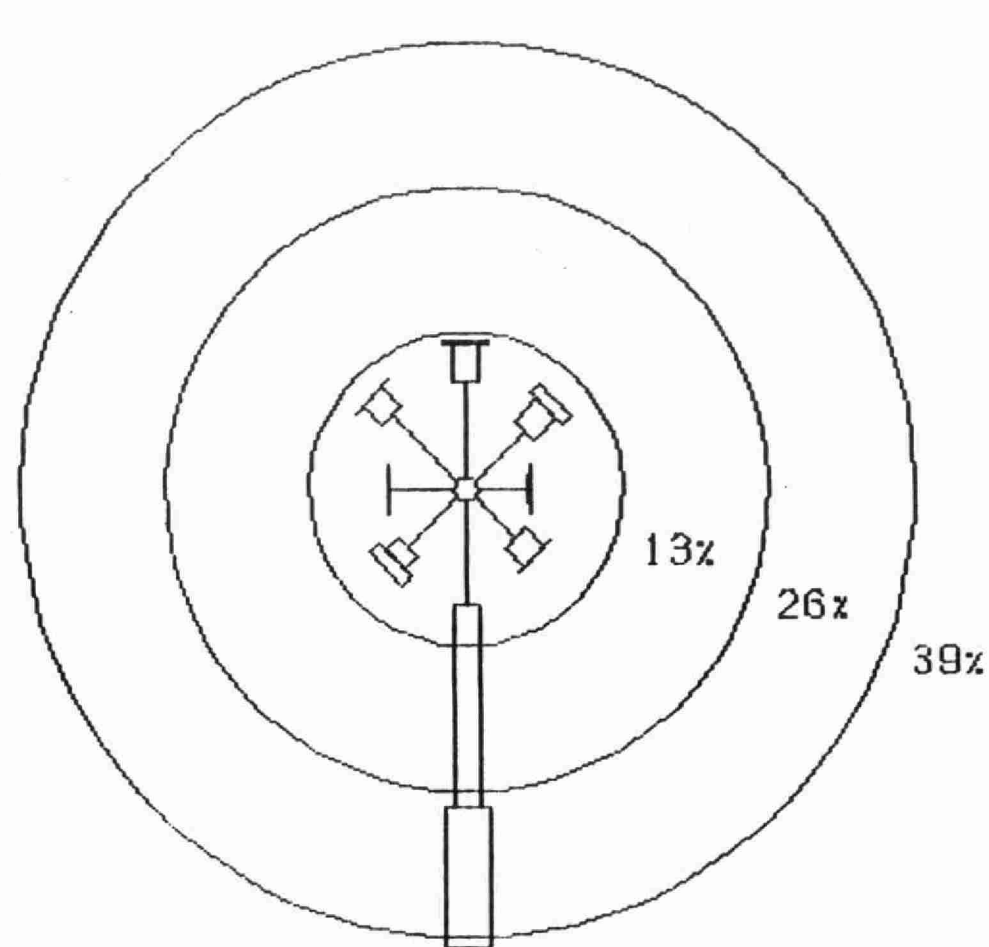


FIG. 2.19: CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1410 (SEP 83)



LEGEND

- 1.5 - 8.0 CM/S
- 8.0 - 14.0 CM/S
- 14.0 + CM/S

FIG. 2.20 : CURRENT ROSE HISTOGRAM: THUNDER BAY L. SUPERIOR

LOCATION - 1407 (MAY 83)

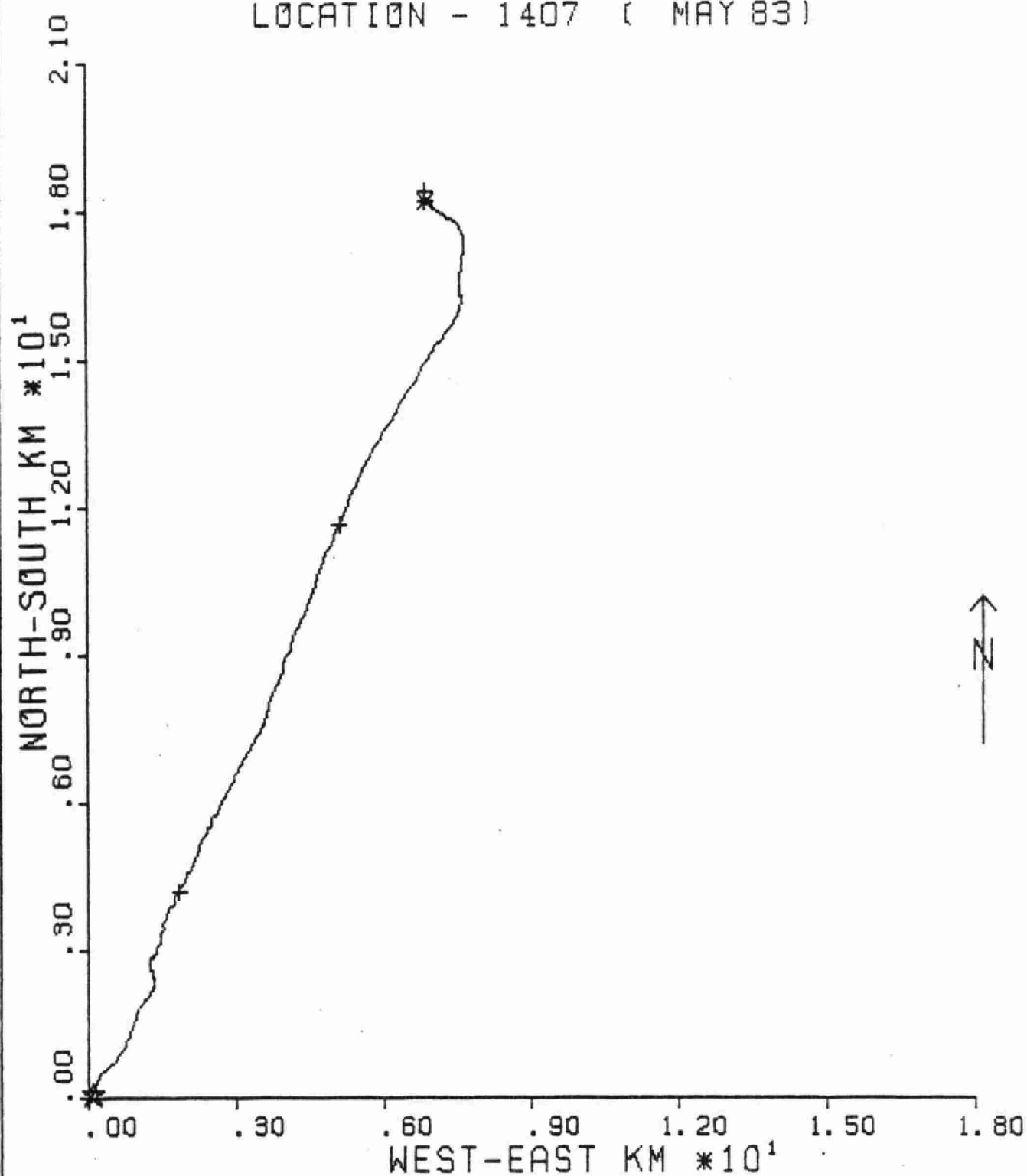


FIG.3.01 PROGRESSIVE VECTOR PLOT: ☆ START AND * END OF RECORD
THUNDER BAY L. SUPERIOR

LOCATION - 1408 (MAY 83)

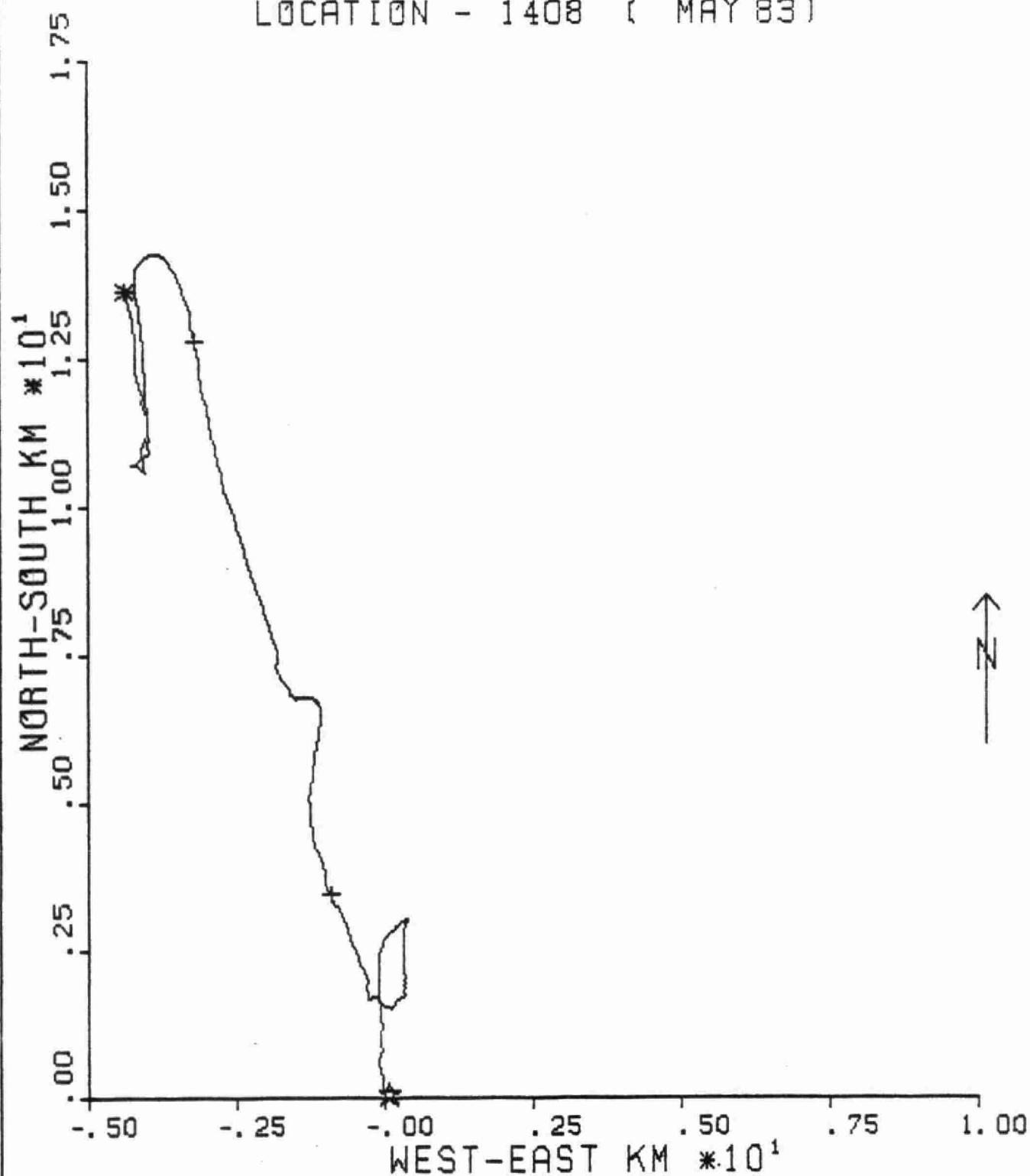


FIG.3.02 PROGRESSIVE VECTOR PLOT: ☆ START AND * END OF RECORD
THUNDER BAY L. SUPERIOR

LOCATION - 1409 (MAY 83)

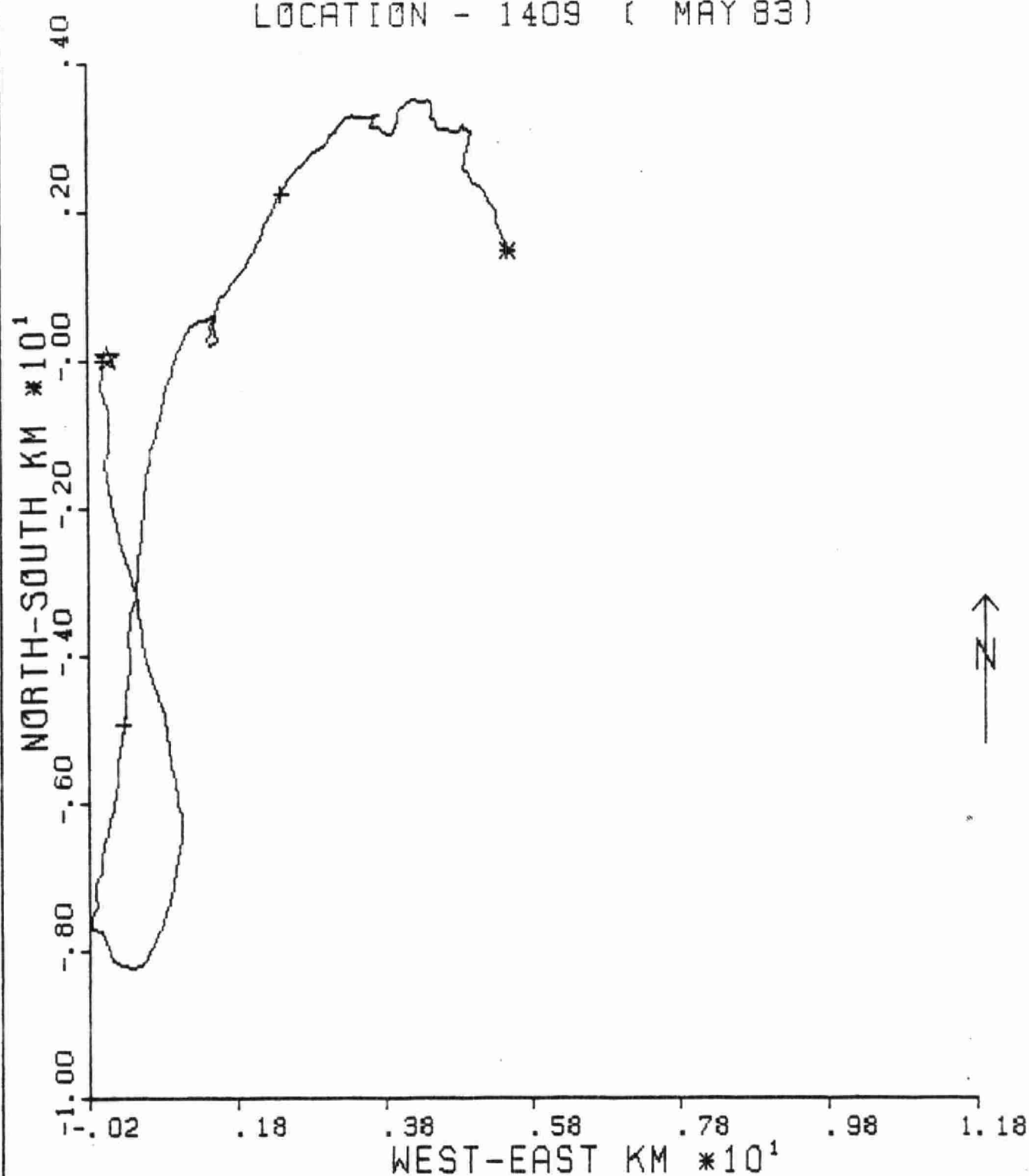


FIG.3.03: PROGRESSIVE VECTOR PLOT: ☆ START AND * END OF RECORD
THUNDER BAY L. SUPERIOR

LOCATION - 1410 (MAY 83)

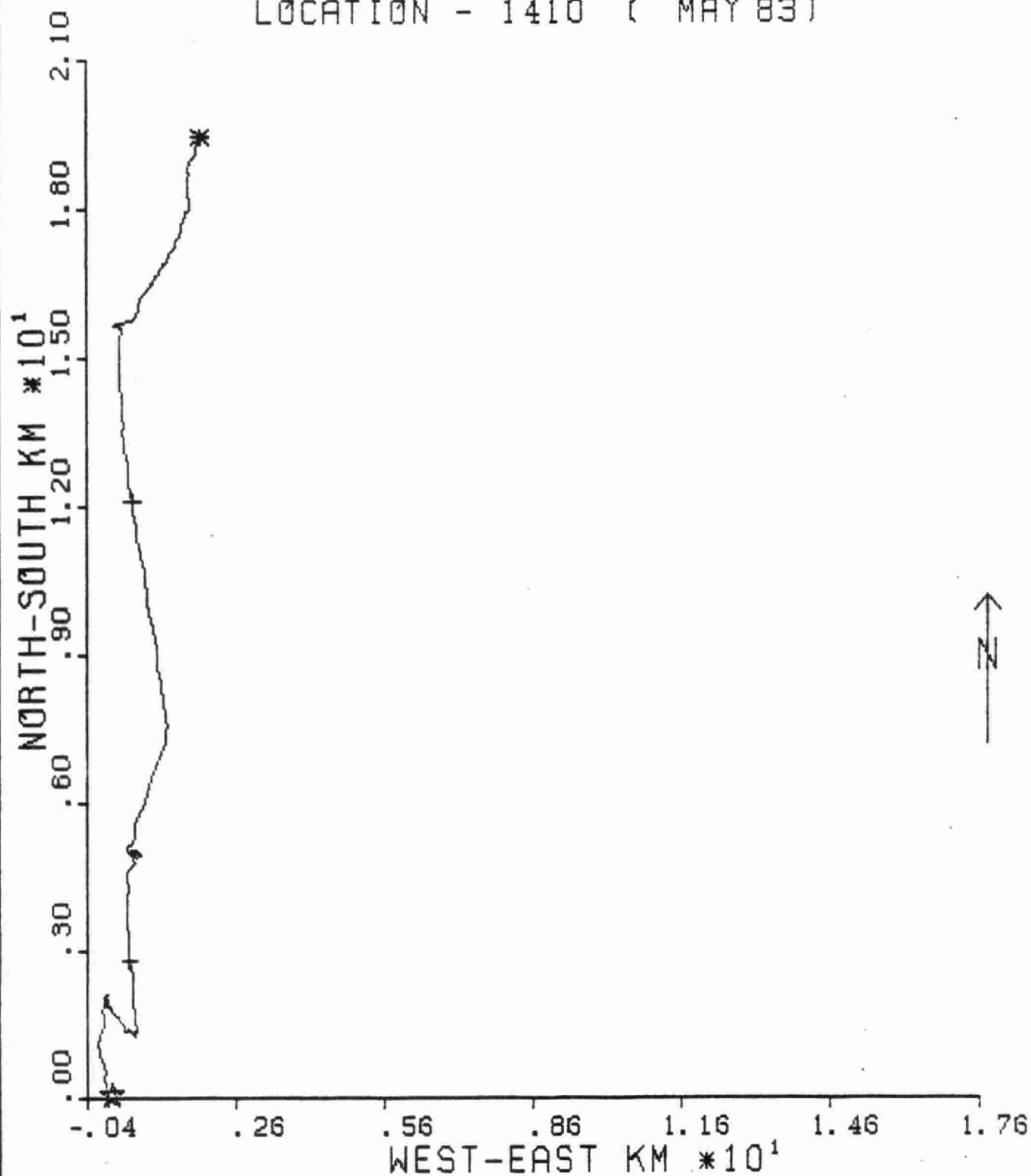


FIG.3.04: PROGRESSIVE VECTOR PLOT: ☆ START AND * END OF RECORD
THUNDER BAY L. SUPERIOR

LOCATION - 1407 (JUL 83)

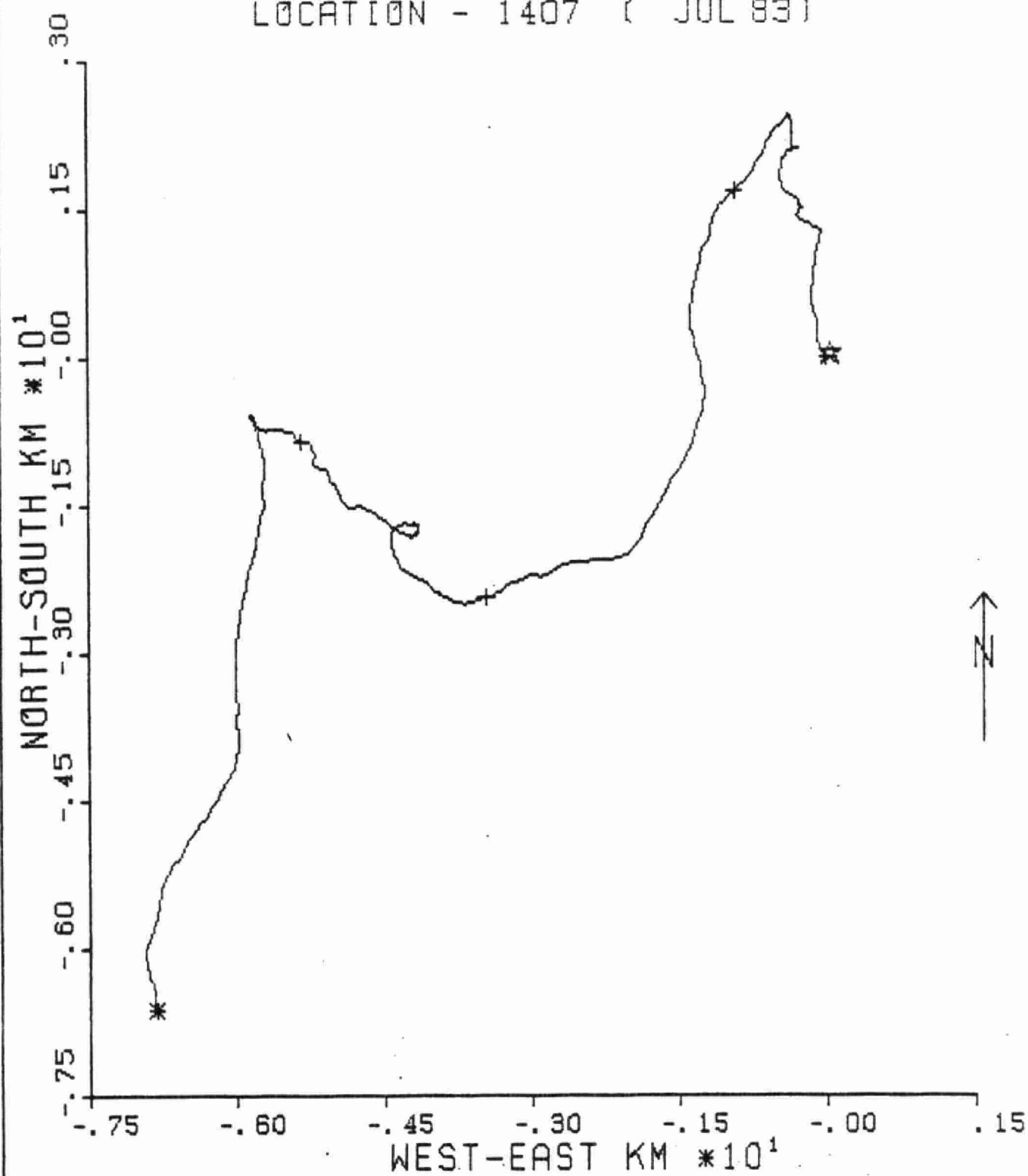


FIG.3.05: PROGRESSIVE VECTOR PLOT: ☆ START AND ☆ END OF RECORD
THUNDER BAY L. SUPERIOR

LOCATION - 1408 (JUL 83)

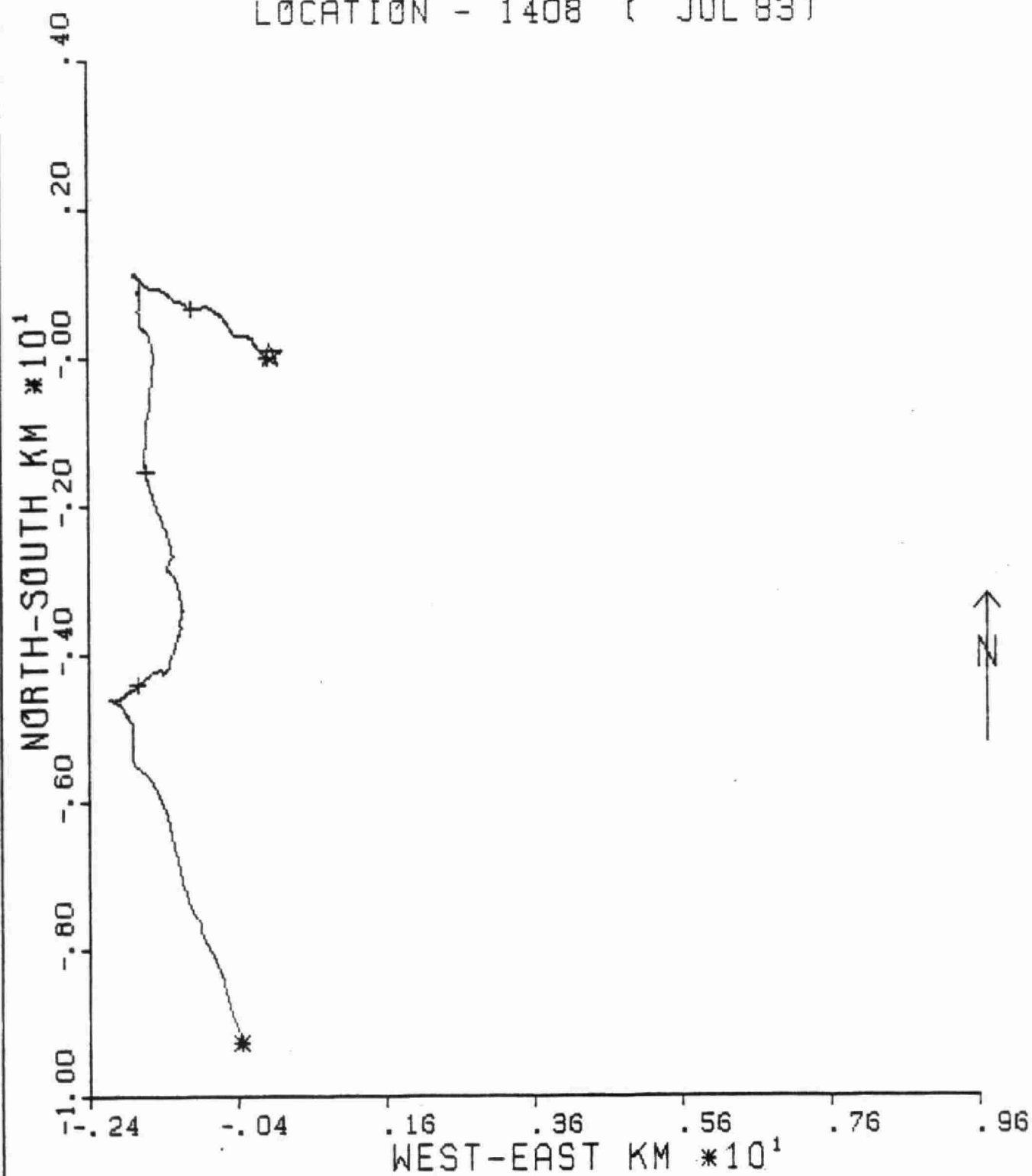


FIG.3.06: PROGRESSIVE VECTOR PLOT: ★ START AND * END OF RECORD
THUNDER BAY L. SUPERIOR

LOCATION - 1410 (JUL 83)

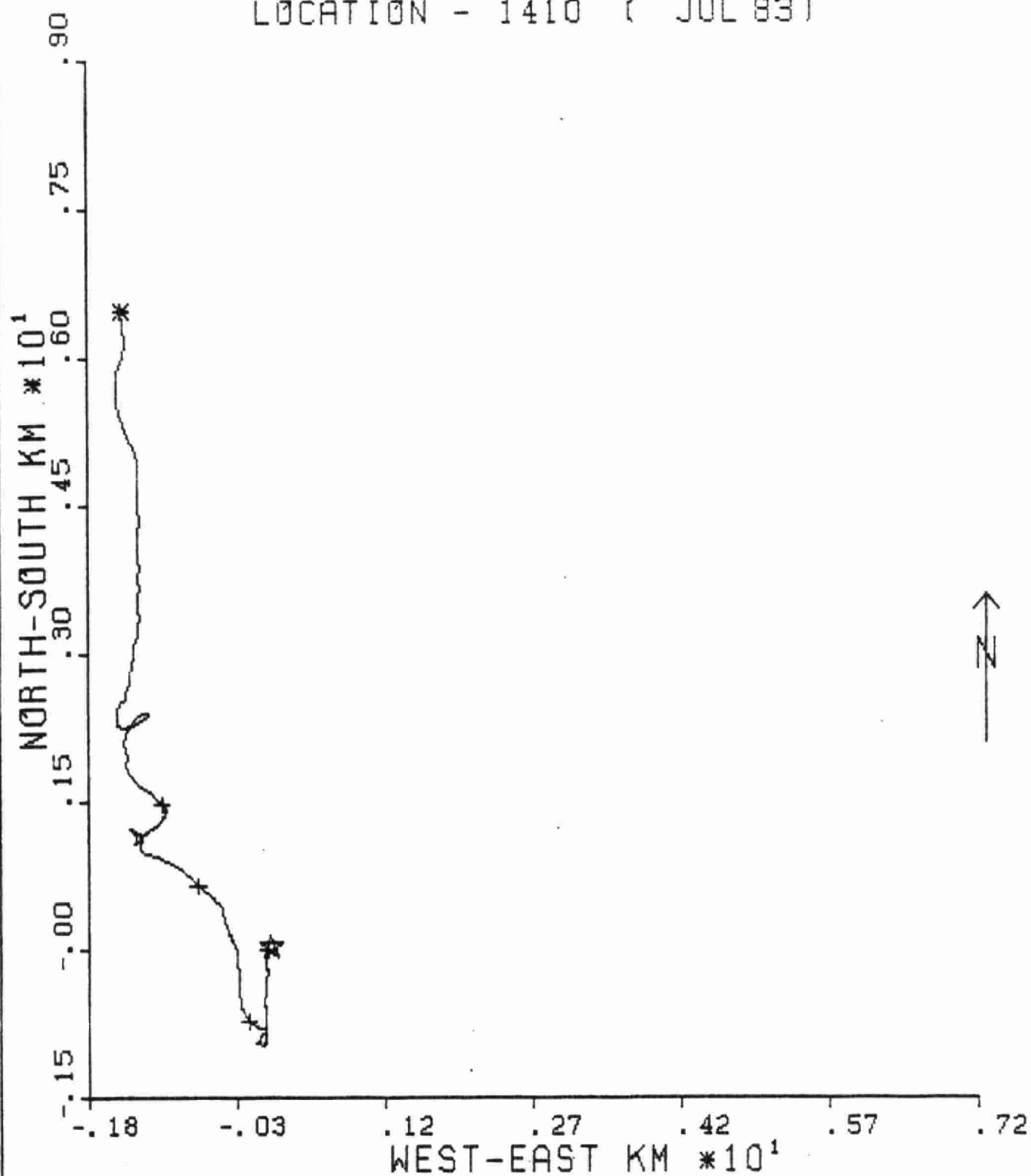


FIG.3.07: PROGRESSIVE VECTOR PLOT: ☆ START AND * END OF RECORD
THUNDER BAY L. SUPERIOR



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